DOCUMENT RESUME

ED 305 506 CE 052 250

TITLE Technology Education: A Perspective on Implementation.
INSTITUTION International Technology Education Association, Reston, VA.
PUB DATE 85
NOTE 37p.
AVAILABLE FROM International Technology Education Association, 1914 Association Drive, Reston, VA 22091 ($7.00 members; $8.50 nonmembers).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052) -- Collected Works - General (020)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Curriculum Development; Educational Needs; *Educational Philosophy; Educational Resources; *Industrial Arts; Models; Program Development; *Program Implementation; Secondary Education; *Standards; Technical Education; *Technological Advancement; *Technological Literacy; Units of Study

ABSTRACT

This monograph has been developed to give educators a broad perspective of the technology education emphasis that is becoming prevalent in schools today, replacing industrial arts. The report is organized in four sections. The first section presents an overview of education in a highly sophisticated technological society. This section contains the following papers: "A Perspective on Education" (Ernest L. Boyer); "People and Culture in Our Technological Society" (Walter B. Waetjen); and "The Nature of Our Technological Society" (James R. Johnson). The second section presents a definitive study on the history of technology as interpreted by the profession as well as its status in other countries. The two papers in this section are "A Progression of Technology in Industrial Arts Education" (Kenneth Phillips); and "Technology Education: An International Perspective" (Ronald D. Todd). The third section of the report provides guidelines for technology education programs, and the fourth section contains examples of successful technology education programs in various parts of the United States. Contributors to section 4 include Les Litherland, Jerry Weddle, Steven Cook, Michael Hacker, and Robert Daiber. (KC)

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Technology Education:

A Perspective on Implementation

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Introduction

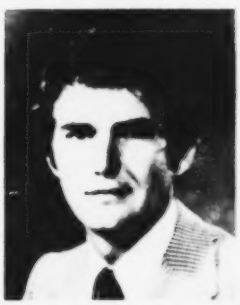
Industrial arts education has undergone a tremendous transition into a curriculum thrust that has become identified as technology education. This publication has been produced to give the interested professional educator a broad perspective of the technology education emphasis that is becoming so prevalent in our schools today. This broad perspective has already been interpreted by various state associations, schools, and agencies in a meaningful manner that is adaptable to their needs. The sections of this publication have been written to give a perspective that presents an overview of education in a highly sophisticated technological society, a definitive study on the history of technology as interpreted by the profession as well as its status in other countries, guidelines for technology education programs, and examples of successful technology education programs in existence in various parts of the United States.

This publication has not been designed to prepare an individual to teach technology education upon the review of the document. It is designed as a primer that must be followed with additional in-service and reading before implementation will be successful.

On behalf of the International Technology Education Association and its members, we hope that you find this publication a basis for further thought and action leading to a better understanding of technology and its important contribution to the overall education of the individuals in our society.

Boyer

Cook



Daiber

Hacker

Johnson

Litherland

Phillips

Todd

Waetjen

Weddle

SECTION I

A Perspective on Education

Ernest L. Boyer

In 1983, we had a rising tide of school reports. We had an army of experts on leave from Mount Olympus, espousing solutions for the public schools. Recently, this has caused quite a deal of excitement and confusion.

In the fall of 1983, the Carnegie Foundation joined the great debate and released its own report on secondary education, which was the result of almost three years of visiting high schools from coast to coast. In the report, we focused on 12 essential themes. I would like to focus on just five of these priorities.

In the Carnegie Report, we begin by focusing on purposes and goals, and we say that schools and colleges, not surprisingly, must have a clear and vital mission. We insist that students, teachers, administrators, and parents should have a shared vision of what, together, they are trying to accomplish.

Now, I understand how boring it can be when one starts to talk about education. Anyone who has served on a curriculum committee or has read articles about education can certainly be wary of the process. In fact, it was no less the likes than James B. Conant who said, about 25 years ago, that "when someone wants to talk to me about the purposes of education, a sense of weariness overtakes me." I suspect all of us have the shared the weariness of Dr. Conant.

But, I have to tell you that one of the most distressing aspects of our school visits was the absolute and sustained confusion about why the school was there and what the people were seeking to accomplish. Without being unkind at all, I can say that principals seemed preoccupied with survival; teachers were concerned about covering the lesson plans; and students were coming together to meet their friends. There was, quite simply, no overarching vision that seemed to guide the institution.

For at least two to three decades, we have, quite frankly, had a crisis over goals in public education. Special interest groups have pushed our schools toward their own self-centered ends, and we have expected teachers and principals to be both parent and police for our children.

Let me go one step further. In preparing our report, we studied the education laws in all 50 states. If you have any inclination toward vertigo or nausea, it is a process I would not recommend. Just to give you a hint at what we found, I will cite three examples.

The State of California's education code says each teacher shall endeavor to impress upon the minds of pupils patriotism, which is fine, including, they say, kindness toward domestic pets. You get the feeling that if you want to be patriotic, you should pet your dog. My dog comes to me wagging his tail to test my loyalty to the nation.

In the State of Maine, the state education code says that the public schools must teach virtue and morality for not less than one-half hour every week. I wonder what goes on up there the rest of the time.

It is no longer possible for us to load on the school obligations that the community, the home, the church, and the parents have not been able to accomplish.

The law in Maine goes on to say that morality shall include justice and the sacred regard for truth, love of country, humanity, universal benevolence, sobriety, industry and frugality, chastity, moderation, and temperance. Then they add, just to be sure, "and all other virtues that affect human society." All of that for one-half hour every week.

The State of Wisconsin is a model of boosterism. They say in the education code that every public and private elementary and high school shall give instruction in the true and comparative vitamin content in food and the health value of dairy products. That's from the dairy capital of the nation.

The simple truth is that if schools, educators, and teachers were to obey all the barnacles that have been attached to the ship of education state, we wouldn't extend the school year several weeks, as the National Commission proposes, we'd have kids in school for 60 years. Even then, we would not have covered all that the people in this country, through their legislatures, have asked our schools to do.

It's time for us to be clearheaded about what this institution can and cannot accomplish. It is no longer possible for us to load on the school obligations that the community, the home, the church, and the parents have not been able to accomplish.

And without being irreverent, the fact the U.S. Congress spent several weeks debating prayer in schools is an illustration of how too many people expect the schools to be the prayer place of the nation. One has to ask, Where are the parents? Where are the churches? And, yet again, we expect the schools to achieve a level of morality that our other institutions have not successfully achieved.

The National Commission report was entitled, *A Nation At Risk*. The National Commission said that America is slipping in the high-tech race, that we are engaging in unilateral disarmament, and that we need better schools to maintain our competitive edge.

Now, I do not want to be misunderstood. I believe the schools have a central role to play in the technology race that we face and I will return to that theme later on.

But, we are living in a dangerous, interconnected world driven in part by the very technology we have developed. And, our vision must not just be national but global as well. Thomas Jefferson had it right: In a democracy, education, among other things, is for civic understanding. I suggest we sharpen and clearly understand our goals. I only hope that our definition of purposes will be as broad and as inspired as the times demand.

The second theme is the key to excellence called mastery of language. I believe that language is the basic of the basics. It is the total by which our humanity is defined. To me, language is not just another subject. It's the skills by which education is pursued and by which all other subjects are then mastered.

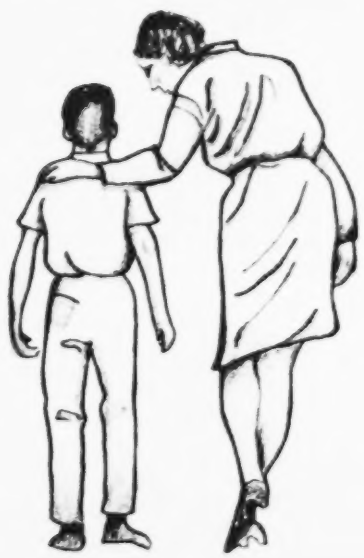
An interesting feature is that language begins long before children engage in formal education. My midwife wife insists that language begins *in utero*, before the unborn infant is delivered and as the unborn child monitors the mother's voice. She also thinks that when a child is born, he or she turns almost instinctively to see the face behind the voice.

Well, putting that exotic thought aside, I am convinced of one thing, and that is language begins with the first breath at birth. And, with that first breath, the child starts receiving signals, starts formulating issues and ideas. Within the first months and years of life, the vocabulary is well shaped; the child masters complex syntax.

I am absolutely startled at the mastery of language and the way subtle meanings can be understood and conveyed far before formal schooling takes place. Now that I am a grandfather and can watch that process with more objectivity than before, I see perhaps the greatest of all gifts—the mastery of language—is just assumed or taken for granted when, in fact, it is that which makes us truly human. I suspect it is what is meant when we say that we are a little lower than the angels.

One of my favorite authors is Lewis Thomas, the chancellor of the Sloan Kettering Cancer Center in New York. In a recent essay, he said he has often wondered why the human species takes so long to become independent when other forms of life seem to be able to march off quite independently very soon.

To put it quite simply, language is the core of all further learning, and those who care about excellence must give priority to language. It should be the first priority the first day of every school, and it should be continued throughout all formal education.



Here I should pay tribute to my own first-grade teacher, who inspired me perhaps more than any other. It was about a 100 years ago when I first went to school in Dayton, Ohio, and walked hand-in-hand with my mother (the first and only time I did that; I was teased and I kept my mother at home from that point on). But on the way to school, I asked my mother if I would learn to read that day. My mother said, "No, you won't learn to read today but you will before the year is out."

Well, I've often thought of that question because it's my own opinion that children go to school to learn to read. They want to break the adult code and find out what all those secrets are about.

But my mother did not know Miss Rice, my first-grade teacher. I walked into that class absolutely frightened and awestruck by the circumstance and there she stood—half human, half divine. For months I thought she ascended into heaven in the evening and descended into the classroom to teach the class.

In any event, she then addressed 28 young, frightened, inspired children and said, "Good morning, class. Today we learn to read." Those were the first words we ever heard. Not one child said, "No, not today. Let's string beads." If Miss Rice said you learned to read, you learned to read.

We spent all day on four words: *I go to school*. We traced them, we sang them, recited them, even prayed them. Incidentally, I did hear that the one prayer in school that is acceptable to all faiths is, "Dear God, don't let her call on me today." Someone else said that as long as there are final examinations, we'll always have prayer in public schools.

I remember Miss Rice, and I think, as a matter of fact, she has shaped my speech to this day because she said, "Good morning. Today, we learn to read." She affirmed the fact that nothing else will follow unless we understand the language.

In our search for excellence and while we're casting about for merit pay and trying to urge that the Defense Department move into the public schools, there is a simple remedy available to us: to understand the centrality of language. I also urge that writing be understood to be perhaps the most important and most neglected language skill.

And, I urge that we define our language broadly. After all, we communicate not just verbally but in nonverbal ways as well. Perhaps it's my Quakerly inclinations, but I wish our children would understand the power and the beauty of silence as a means by which we communicate with each other and with ourselves.

My grandfather used to to think that unless you are silent, you are not communicating. Noise was tolerated when you had something essential that you wanted to say, but silence was the preferred relationship with others.

Our children should understand that we communicate not just through words but through music, through dance, through the visual arts, and even through the craftsmanship and the beauty of those things we create. They make a statement about who we are, about how we're feeling, about messages we wish to send to others. The power of language, then, is the power of those symbols we present, including those marvelous creations that our hands and minds have shaped. I believe the very nature of civilization is to be defined by the breadth of the simple systems that we use. If we depend only on our words, we've denied ourselves other channels by which some of our most exotic feelings and ideas can be captured and transmitted to each other.

It's no accident that when dictators wish to control the minds and hearts of men and women, they not only silence speech, they also censor music and dance, the visual and the creative, and the technical arts because they know these tools are the means by which we express feelings and ideas.

The third theme in our report is that excellence in education means a core of common learning. We've been hopelessly unclear about what it means to be an educated person, and this has left our students uncertain and divided.

The question is often asked, Do we have anything in common? During my days in the university world and during the anguish of Vietnam and Cambodia, I was shouted down, locked out, pushed in, interrupted. How many times did I hear from my young friends that somehow the gap between us was so great that there was no point at which we connected because I was, unhappily, over 30.

Well, after they told me that we could not communicate at all, I reminded them that the very fact they argued with me that we had nothing in common assumed, on their part, that we had enough in common for me to understand their arguments that we had nothing in common.

We do have many things in common. Several months ago I flew to see my son,

his Mayan Wife, and my granddaughter in Central America. Within several hours, I was around an open fire with my son's in-laws in a civilization that dates 1,000 years before North America was discovered. I wondered if there were ways to bridge a gap between the world I lived in in North America and their culture, dating back thousands of years.

But, then we did begin to engage in the use of the symbols, primarily visual, to be sure. We discovered that we have memories of the past, human experiences that no other form of life enjoys. We could anticipate the future, which is a uniquely human experience. We have mores, traditions, and institutions, which we could compare. We have hopes and fears. And, we have the common experience of producing and consuming, which I believe is universal in all time and cultures.

Now, I understood my son's in-laws' work: They planted crops and harvested the crops. It took me almost an hour to convey the nature of my work, which is carrying paper and catching airplanes. Nonetheless, the broader point is that all people share the universal experience of producing and consuming. We have made a tragic mistake in teaching our students to be so individualistic that they fail to see what we share in common.

Archibald MacLeish said that seeing the connectedness of things is the first essential goal of education. Those who evaluate the quality of our schools should begin by asking, Have our students learned the larger vision?

I am not suggesting a rigid set of courses. I am suggesting that if education is to prepare our students for the future, we must understand those common themes by which we share a common civilization and heritage.

The fourth key to excellence is the centrality of the profession of teaching. We have seen our schools decline because we have neglected the simple fact of the centrality of the classroom and the teacher. I worry that in our efforts to reform the schools, we may have imposed standards that suffocate rather than revitalize the role of teachers.

During our study, we found that the basic problem is not salary or merit pay, although teachers are underpaid. We concluded the basic problem is the teachers' working conditions. I mean by that too many students in a given day, classes with too brief a time for teaching, too little time for preparation, too much paperwork and bureaucratic intervention, and too many idiotic interruptions.

My pet peeve is the PA system. It is a symbol of what's gone wrong in American education. I agree entirely with the teacher who told us that the first step for excellence in education is to unplug the PA system. I was in a class for 50 minutes, and that idiot box interrupted three different times with announcements on the pep rally, late slips, and all those earth-shaking matters.

I am as serious as I can be: Any system that carelessly and repeatedly interrupts a classroom without warning and does not give the teacher the dignity of a few moments to present his or her ideas is, in my judgment, a system in decline. We cannot have quality education when we say to our students, "After we get all the other logistics worked out, then we'll get back to teaching."

One of Winston Churchill's most memorable phrases was, "Give us the tools and we will do the job." I happen to believe that is a key to excellence. We must give teachers both the dignity and equipment that's essentially required. Then we will, in fact, start on the road to excellence.

I stress this point of teacher excellence because when all is said and done, these reports are not going to save education. Action for legislatures is not going to save education. But a new sense of vitality and dignity and status, felt in the classroom and by the teachers, will save this nation.

I'm always stunned at the power of the teacher. Some months ago, I did a television interview in Los Angeles. The cameraman came around to see me almost before the red light had gone off and said, "You know, I just have to tell you about my first-grade teacher."

Here was a guy who was 60 if he was a day, telling me about his first-grade teacher. He said, "She went on a Christmas holiday, and she sent me a picture postcard. I don't remember the picture on the card, and I don't remember the message that she wrote." He continued, "But, I'll never forget the fact that she addressed the card, 'Mister Peter Andrews'." And then this old duffer looked at me and said, "She called me 'Mister.' She thought I was somebody."

Fifty years later this man was still basking in the glow of a picture postcard. I think it's both amusing and inspiring. Somehow that simple, perhaps unintended act by a first-grade teacher helped that young child define who he was and what he would become. He was still living on the expectation that somehow he was somebody.

In every classroom, every day, signals are being given that either diminish or inspire the vision of students. I believe that the pathway to excellence comes in the rewarding of the teacher.

The fifth priority for excellence, which I happen to believe in passionately, is acknowledging the dignity of work. The truth is that work is at the very heart of our existence. It's through work that we define who we are. And it's through work that we give special meaning to our lives.

Education is not simply something we engage in as an end in itself. We develop our talents, our skills, and our ideas in order to be productive, to make something useful of our lives. That's what I mean by work. The time has come to acknowledge that a study of work is a part of the core curriculum of every student.

What I find scandalous today are the mindless distinctions drawn between the so-called academic and nonacademic programs. I find it equally scandalous that some jobs are generously approved while others are cynically condemned.

Some say it's all right to be a doctor but it's less all right to be a nurse. It's all right to be an engineer, but a computer programmer is less honored. Teaching college is just great, but teaching elementary school is demeaning.

It's a curious profession we're in. The least recognized are the ones who teach the younger children, and probably more of them. The way to be really outstanding is to teach old people, and fewer. Something's very mixed up about a profession that gives honors to those who teach the older and denies dignity to those who teach the young, where the most influence is to be achieved.

I am also impressed that to dig ruins, as an anthropologist, is a respectable objective. But to work with ruined lives in an American jungle—that is, sociology—is not quite as worthy.

I ask you, What logic is used by those who make these silly, invidious distinctions? And who gave these people the right to guard the academic world and to determine what is legitimate and illegitimate for our students?

In the Carnegie report we say that a seminar on work is a part of common learning; it should be a part of the required core. It should recognize the full range of occupations and that work has been central to human history.

In fact, one powerful way to understand any civilization is to ask about the nature of work in that culture. Who works? Who's rewarded? What's been honored? What's

been denied? Yet, the sad fact is that work has been essentially ignored in our study of the human experience.

In the Carnegie report we also call for a study of technology by all students. I do not believe that we can within the four walls of every school and within the four years of high school prepare students for every specialized occupation.

But, we can and must help every student learn about the technology revolution, which will dramatically shape the lives of every student. And it's here that the industrial arts educator has a crucial role to play.

The urgent need is not computers, which have become scandalous diversion. We saw hardware being purchased in school after school. And when we asked administrators, "To what end?", they had no answer. It's a case of buy now, plan later. And the resulting waste and the destruction will bring us regret later on.

The issue is not computers. The issue, rather, is the changing of our society, driven by a technology revolution that is as fully important as the industrial revolution over 100 years ago. By that I mean the changes in our manufacturing, the changes in our construction, and most especially the changes in our networks of communications and in the transportation that moves us from place to place. Your profession [technology education] must take that remarkable document, the Jackson's Mill statement, and bring it in a practical fashion to the school and to the classroom.

Here, then, is my own conclusion: I believe that the false barriers between the so-called academic and vocational should be broken down. The truth is academic programs are, in fact, preparing students for a vocation. And the other truth is that vocational education also introduces students to great literature, to basic scientific principles, and to enduring values, if they are taught with the power and insight that they deserve.

I believe that it is absolutely tragic to divide our students arbitrarily, to say to some of them, "You're the workers" and to others, "You're the thinkers." In fact, life for all of us is a blend of both. In a given day I don't know when I'm a worker and when I'm a thinker. If I'm living a life of integration, I'm blending both my skills and my ideas. And if that is true in our lives, why is it not true in the education that we are presenting to our students?

Putting it simply, I believe our goal must be quality education for all students, not just a privileged few. It should be a quality education that helps them understand that life is a blend of work and further education.

On *Firing Line* some months ago, Bill Buckley was having a marvelously brilliant exchange with Mortimer Adler. Near the end of it, Adler was talking about his publication, *The Paideia Proposal*, which has quite an inspired vision for all students.

Your profession [technology education] must take that remarkable document, the Jackson's Mill statement, and bring it in a practical fashion to the school and to the classroom.

Near the end of the show, Buckley said to Adler in his rather unusually self-confident manner,

"Mortimer, what makes you think all children can learn?" And Adler, without skipping a beat, stuck his finger under Buckley's nose and said, "Well, I want to tell you something, Bill. I'm not absolutely confident all children can learn, but then again, you're not absolutely confident they can't. So, I'd rather live by my hope than your doubt."

Whether we like it or not, our vision of education in this country has been built on hope. The moment we start developing our plans built on doubt rather than hope, the future of this nation is in peril. I genuinely believe all students can learn if teaching is inspired.

I was in a sixth-grade open classroom in New Haven, Connecticut, in the middle of our study. Incidentally, I'm not fond of open classrooms. They're really open traffic jams. I have this fantasy that architects who design them will spend eternity teaching in them.

I walked in and there were some 35 inner-city children, pressing the teacher against the wall. I discovered that they were engaged in reading Charles Dickens' *Oliver Twist*. For 30 minutes I stood watching the students' intensity. They were all cheering for little Oliver, who was struggling in an urban jungle.

That teacher had performed a miracle. She had brought nineteenth century London to New Haven. Every child there was identifying with that little kid; they knew the good guys from the bad guys. And when someone tells me that children cannot learn great literature, I say, "Nonsense, I saw it and I heard it." It was simply a matter of a teacher who taught a universal theme that every child shared. They were so captured by the theme, they were able to overcome the curious syntax in the language of a nineteenth century writer in London, England.

James Agee is one of my favorite 20th century authors. He wrote on one occasion, "With every child who's born, no matter under what circumstances, the potentiality of the human race is born again." I happen to believe that's true.

This is one of the most exciting and momentous moments in American education. We have a greater opportunity now than at any time in this century to reform and strengthen public education. I think we can have excellence—if we can clarify the roles and our goals and stress the mastery of language, if we can agree in some degree on a course for our schools, if we understand and support the teachers, and above all, if we can reaffirm the dignity of work.

Let's recognize that we have children with many talents, and recognize that teaching is a noble profession. If we can find a way to relate technology to the larger values, then I believe this nation will not only survive, but, for coming generations, will flourish with dignity as well.

Since January 1980, Ernest L. Boyer has been president of the Carnegie Foundation for the Advancement of Teaching. He is also a former U.S. Commissioner of Education. *This presentation was sponsored by a grant from the Technical Foundation of America, Lansing, IL.*

People and Culture in Our Technological Society

Walter B. Waetjen

Shakespeare once said that time is a thief. One can only speculate as to the message he intended to communicate. He might have said that time robs us of opportunity—as any athlete will attest. Moreover, time may be a thief because it lulls us into believing that we are fully aware of all that goes on in our surroundings when, in fact, events speed by so quickly that our remembrance of them is selective. As a consequence, we are insensitive to the way in which technology has crept into every aspect of our lives.

The office worker, with skills that were appropriate 25 years ago, is not only helpless but even unemployable in the modern office, where a shift from paperwork to operation of electronic machinery has vastly changed the nature of work while providing better service to customers and improving productivity. Similarly, the technological revolution has influenced commerce to the point where all of the economic interactions among members of our society (finance, transportation, communications, and distribution services) are being mechanized far more rapidly than the production of goods. Electronic transfer of funds has almost made the paper check a thing of the past.

Agriculture has experienced the same change. Formerly, an individual who could not make a go of it in any other work activity could always turn to agriculture. That is no longer true, for technology has produced highly complicated machinery, sophisticated chemicals for controlling insects and undesirable plants, and computers that enable farmers to tell when to plant, when to harvest, and when to sell their crops. Even with these few examples, it is clear that the fabric of American society has changed, is changing, and will continue to change. The major theme is that technology has wrought changes in the way we live and work. The subtheme is inescapable: More education is required as technology becomes more complex.

There can be little doubt that improved technology has changed our life-style, the economic base of society, industrial productivity, and cost and availability of consumer goods. Historians are known to describe eloquently how the work week of industrial workers has declined from 60, to 50, and now to 40 hours per week. At present, there is thought of further reducing the work week. Although it is not at all clear what workers will do with more leisure time, there are strong advocates for more of it.

Thus, we have a problem in that technology has consequences, a not very profound statement. One wonders, however, whether we consciously examine all the consequences of new technology. Indeed, one can speculate that we tend to dwell heavily on the positive consequences of technology while we overlook, ignore, or disregard more negative consequences.

What we are witnessing, however, is that the values of American society are changing because of technology.

Diplomats and others who are immersed in sensitive international relations could conceivably have a different view of the instantaneous communication of information by use of advanced technology, including satellites. In Revolutionary War days, a strain in the relationship between two countries would probably be met by a carefully worded letter being drafted by one head of government and sent by emissary to the other government. Without telephones, satellites, telex, or jet plane travel, a considerable amount of time elapsed from receipt of protest to delivery of response. Although that lapse did not always result in the perfect solution, time was available for a "cooling-off period," the development of alternative responses, and achievement of detente.

Technology has reduced this response time to almost zero. The possibility that adversarial relationships will develop instantly increases enormously. Technology makes available more information in a much shorter time. That is the positive aspect of technology. On the other hand, we are less likely to recognize that instantaneous communication (technology) may have serious drawbacks for individuals and corporations, as well as for nations. Under such conditions, adversarial relationships can develop much more quickly than anyone might desire.

Each year, approximately 55 new chemicals are devised, and with the advent of each we hail the new product it will help us to create. Improved film, food preservatives, plastic plumbing, and rocket propellants are examples of what new chemicals have made possible. The negative consequences of these complex chemicals that derive from our technology usually emerge much later. Only in somber morning-after moods of reflection do we recognize that the down side of new technology was not considered. Had it been, we would not have asbestos in every hotel and motel, restaurant, recreation center, church, elementary and secondary school, and university structure. Likewise, we would not be contending with dioxin in ground aquafers.

By taking the position that the good aspects of technology must be implemented immediately and the negatives omitted from consideration, we make a value statement to the young people of our society. Progress must be made at any cost, we seem to say. Or is it that financial gain is the major consideration in technological advances?

What we are witnessing, however, is that the values of American society are changing because of technology. In this connection, Mesthene (1970) posits that technology has a role in changing cultural values simply by introducing new options for choice or by virtue of changing the course of realizing an option. Moreover, he claims that technology introduces contradictions in our value system, and in that sense, technology can cause disintegration. In our present situation, it may be necessary to revert to the time-honored values of cooperation, social responsibility, and corporate modesty rather than hyperbole. Clearly, the so-called "bottom-

line" analysis of the quarterly earnings statement cannot determine our value orientation.

Labor unions have tried for years to make the case that production workers have problems not experienced by other workers. The argument is that there is a great deal of tedium on production lines and a higher than normal incidence of personal injury. The response has been to provide workers with rest breaks, coffee breaks, piped-in music, advanced safety equipment, and improved medical services. One must be careful not to criticize those actions for they have dealt with the problem, but only by dealing with the symptoms. The symptoms are related to the creative and artistic nature of human beings that technology violates.

Production workers, while creative in a sense, perform only within a rather narrow range of their total creative capability. Rarely do they deal with a total project involving use of a wide range of their skills and creativity. When one never sees an end product and produces only one part of the end product, work becomes monotonous and boring.

Studies demonstrate that anxiety increases with boredom and individuals become increasingly unable to focus on specific problems. In other words, cognitive functioning is impaired, a condition that is unsatisfactory to the worker and ultimately leads to a lower level of productivity in quality or quantity. Much of this can be attributed to a technology that is heavily based on electronic information, mechanical power, and metals. These have taken the place of handicrafts, which were based on wood and the muscle power of human beings. In the latter situation, it was more likely that the worker made an entire product, thereby employing a wide range of individual skills to produce articles that were aesthetically pleasing at the same time that they had great utility. Cognitive functioning was high, and so was a sense of personal worth and adequacy.

Even if there could be reversion to an earlier era, one would have to weigh the merits and demerits of the technology of that era against the present technology. Rarely is that type of evaluation done when new technology emerges. Little attention is given to the negative impact of new technology on the physical or psychological well-being of humans. For the moment, let us examine the psychological well-being of those whose work is with machines.

A machine offers no feedback to the operator. It may break or go out of adjustment to the extent that the operator recognizes that something is wrong and makes a correction. Any meaning involved in that interaction derives from the machine operator. In short, the flow of information from the machine (if there is any) to the operator is entirely nonsocial. The same thing may be said of the relationship between the person who operates cathode-ray terminal (CRT) or a personal computer. The flow of social information is unidimensional.

In earlier paragraphs, I described how there has been a separation of the worker from the material; now we see a separation of the worker from other workers. Of the two, the latter may be more significant if we accept the fact that social interaction is the warp and woof of personality development. Ego strength and job satisfaction are derived from appraisals that are reflected to individuals from what they did or said, or how good their work was. Those reflected appraisals are internalized and become part of the individual's perceptions about his or her self and the world.

Technology education in the United States has, for all practical purposes, been focused strongly on the technical side.

It is not enough that a worker is acquainted with a machine and its capabilities. Paramount to the worker's mental health, personality development, and job satisfaction are the subtle, and sometimes not so subtle, evaluations that fellow workers and supervisors communicate to that worker. This makes for a mentally healthy and maturing individual, whether child or adult. Operating machines may teach us much about technological processes and materials, but it falls short of communicating to us the "social stuff" of personality.

In a relatively short period, the United States has gone through a dramatic metamorphosis from an agricultural to an industrial and now to an information society. At each stage, humans have been required to invest less muscle power in work and recreation and more time and energy in education. That is, in an agricultural society, much physical energy was required but a low level of education sufficed. But in an information society, very little physical energy is required but significantly higher levels of education are mandatory. Educators respond to this condition with elation and renewed sense of dedication to their profession.

Learning involves being intellectually curious. The person who asks questions seeks information to satisfy intellectual curiosity. All people are intellectually curious at some time about something. This curiosity makes it possible for people to continue to learn, to change, and to grow as individuals. That they learn, grow, and change is because they initiate action and attempt to evoke responses from people and situations that will satisfy their need for information.

With each year that goes by, children and adults spend an increasing number of hours watching television. Without entering into the argument as to whether television is an intellectual wasteland, it is clear that television watching is a passive activity. Technology has given us this wonderful instrument that makes entertainment or educational information readily available. Whatever the substance of a program, there can be little dispute that the viewer (learner?) is passive. The very technology of television requires that the machine take the active role and the viewer the passive role.

Although all people are passive at times, there must be concern when the number of television viewing hours increases each year. From a psychological viewpoint, there must be concern about passivity and its negative impact on learning. Moreover, passivity would seem to be antithetical to the democratic way of life. Democracy values dissent and a search for alternative methods for solving problems. In short, it recognizes that a person must be an active rather than a passive participant in society.

In the early 1960s, technology gave evidence that it could change educational practice. Television was touted as being the technological instrument that was going to revolutionize teaching and learning in the classroom. It has not. Maybe we did not give it a fair chance, but it is also likely that students were inherently resistant to being cast in the passive role.

The situation is not all bleak, however. Intellectual curiosity is evident in the behavior of the computer "hackers" who try to obtain as much information from as many data files (some now their own!) as possible. The hacker invents problems and seeks information to solve the problems. In this instance, technology has made it possible for the learner to assume a very active rather than passive role in problem

solving. Quite likely, educators have not examined carefully enough how learners can manifest curiosity by use of the computer.

Technology education in the United States has, for all practical purposes, been focused strongly on the technical side. In the elementary and secondary school, we entrust technology education to the mislabeled "shop teacher." At the university level, technology is placed in the hands of the engineers, ceramicists, or print makers. More recently, technology has encompassed computer centers in the university.

No matter the level of education, we do not seem very concerned about technology being taught as a part of the humanities, the arts, or the policy sciences. In making that decision as to how and where technology shall be taught in our educational institutions, we make a strong statement about the perceived importance of technology as it influences our pursuit of the good life.

We cannot confine the study of technology to its technical aspects alone.

Various groups around the world are protesting the proliferation of nuclear power plants and weapons. They seem to be saying, "Why do you not consider how technology can influence either the preservation of our society or the enhancement of the quality of air, water, and food supplies?" Indeed, why not consider such questions? We cannot confine the study of technology to its technical aspects alone.

Universities and secondary schools can use technology as one of the integrators or themes that would run through the entire curriculum. Were this to be done, students might develop a better understanding of the impact of technology on social change. As adults, those students might then have an appreciation for and be motivated to devise and apply ways of measuring how technology influences life-styles.

The risk for our society is to underestimate the importance of the assessment of technological change or to assume that the assessment is entirely a scientific process. The fact of the matter is that assessing the impact of technological change is as much a political process as it is scientific in nature. Because it is so complex, it is difficult to know whether the assessment process should be carried out by government, an independent agency, universities, a specified nation, or whether it should be within the purview of the United Nations.

A central role of an educational institution is to offer a curriculum that gives its students a basic understanding of the society in which they live. Proceeding from that premise, it is logical to assume that in a democratic, technological society, the curriculum would strongly reflect those characteristics.

Almost all areas of the curriculum contain information about the democratic form of government in the United States. The same cannot be said about technology. People are becoming out of touch with a fundamental aspect of their society because our educational institutions impart so little understanding of its technological base.

In our current zeal to improve schools, it is timely to examine how technology might be taught. Time, indeed, is a thief. We should not allow it to rob us of the opportunity to produce an even better educated citizenry.

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The Nature of Our Technological Society

James R. Johnson

Nearly a century ago, my father was born in a small village in southern Ohio. He died this past spring, having lived through 96 very remarkable years. One of his favorite gifts from the world of technology was a "music box," a small tape cassette player from which an "amazing amount of music" could emerge.

In 1888, the blacksmith in my father's village forged iron shoes for horses, the only source of local transportation. Fifty miles away in Cincinnati, many factories running on belts and pulleys driven by steam engines or water power were about to be transformed by electric motors. Long-distance communication was being revolutionized by the telegraph and soon would be augmented by the amazing telephone. At 10, my father watched helplessly as his mother died of measles.

And then, like the release of spores from fruiting mushrooms, the latent seeds of a new technological society were cast into the scene. What happened in those 96 years to make them so remarkable?

Understanding Technology in Our Society

In a mere century, the mechanization of work has hurdled us over factories filled with human workers and machines to nearly people-empty plants filled with computer-guided robots that produce the goods. Voice and image are relayed via satellites for instant worldwide communication. The ancient scourges—smallpox, plague, measles, and the list goes on—have been virtually wiped out or are treatable with miracle medicines. In every corner of our lives we find changes that could not have been dreamed of a century ago.

What is the nature of this new technological society? Perhaps it has moved too fast to have a nature. Things become natural only after they have had time to be accommodated. For some, the miraculous advances are frightening. Illustrating this, Alvin Toffler (1971) cites a recent musical: *Stop the World, I Want To Get Off!* (p. 39). For others, living in third- and fourth-world nations and unable to share the benefits of technology, these advances are a source of bitterness.

But most of us who can choose to enjoy all the privileges born of technology. We would like to know better the nature of our technological society so that we might enhance the benefits over the burdens. We welcome more than we fear science, the progenitor, and look forward to what it may have in store for us. We are confident that we'll find ways of accommodating the problems that inevitably accompany the new gadgets. And yet, in spite of our optimism, we worry about our technological society. We wonder at times with H. J. Muller (1975) what technology is doing *to* us rather than *for* us.

Things become natural only after they have had time to be accommodated.

There have been endless arguments over definitions of technology. Most of the definers belong to the few percent in our society who are themselves technologists. To the average person, technology is a black box. With wheels on it, it can be driven to work or to the supermarket. With hinges and some insulation, it is a door to the refrigerator. With a bit of rounding of the edges of the box, a nose cone up front, and a rocket motor in back, it threatens nuclear winter.

Many of our technologists also are well aware of what technology provides for society, and many share the general concern over its proper use. Anna Harrison (1984) recently defined technology as the process that produces our goods and services, from concept to production and delivery. Its companions—science and engineering—also were defined as processes, each with an interactive role working toward good societal ends (Harrison, 1984). But, Loren Eiseley (1980), with concern for the dark side of humanity, wrote,

> The violence in a raindrop is equalled, if not surpassed, by the violence in a microscopic genetic particle. The one, multiplied, carries away a mountain range. The other crosses an ice age and produces on its far side, a man-ape whose [technology] now endangers his own civilization. (p. 81)

In summary, we the public are aware of the enormous benefits of technology, even though more often than not we take them for granted. As concerned citizens, we sense concomitant burdens or problems along with those benefits; but too often we are stymied over solutions to those problems. As technologists, we understand the technical nature of our technology, but we have barely comprehended its future societal implications, even though we have carefully studied the history of the past century. It has all come too fast and without precedence.

But we must not only understand technology, we also must energize it, use it, cope with it. As the gifts of technology become more pervasive and its concomitant problems more critical, there is a compelling need for broader understanding. The technologists must give more thought to the uses of technology and their impact on society. The nontechnologists must no longer regard technology as something that works magic for or against them.

Much has been said of "technical literacy," usually meaning that nontechnologists must learn some technics. But this is not enough. Modern technology and its societal meanings require a holistic, integrated understanding that permeates all segments of our society. This is for education a goal whose time has come.

The Energy Example

As we move toward the 21st century, our technological society is even more accelerating, breathtaking, and worrisome. Each new technology seems to have greater promise and peril. A key example is our current energy dilemma.

Energy is required to process and provide goods and services. It allows and limits what we can do. The net energy from energy systems governs our material standard of living. It is no accident that the explosion of technology in the past century came with the unprecedented use of fossil fuels with very high net energy yield. The low-yield energy systems of an agricultural society simply would not permit snowmobiles, jet aircraft, and television.

A decade ago, we developed an awareness of our dwindling fossil oil and gas energy resources. This followed the shock

of an Arab oil embargo and the ensuing several-fold increase in energy prices.

As we looked for technical alternatives for our energy supply, we also became aware of problems. One obvious alternative course was to implement conservation, particularly in oil-consuming applications, the largest of which is transportation. The conservation approach has worked well. Smaller, lighter cars now have at least doubled fuel efficiency; however, in the decade of implementation of this "technical fix," one of our largest industries had its own shock. A substantial part of the production of U.S. cars and their jobs moved overseas. Autos produced in the U.S. are now far different from the 1974 models, and the industry is fully committed to automation.

Conservation, nevertheless, has limits—some technical and others economic. For example, the efficiency of an electric plant is ultimately governed by thermodynamics. And, the heat saved through increasing use of insulation at some point costs more than it is worth. What then?

In the transportation sector, our society may eventually give up some convenience, returning to increasing use of common carriers—perhaps a hybrid system that includes private vehicles for local use. Technology will provide a new and possibly exciting way to move about, but it will again bring social and economic changes.

Another energy alternative a decade ago was to return to greater use of coal. With the current end-use applications requiring liquid and gaseous fuels, the first efforts were to design modern coal gasification and liquefaction plants. Because of economics, this alternative has been put on hold, perhaps, ironically, because there is a temporary oil glut as a result of the "technical fix" from conservation. But we were far enough along in the designing and pilot work to begin to see serious water-supply problems, because water, as well as coal, is a feedstock of these plants.

The direct burning of coal produces sulfur oxide emissions. High-temperature combustion of all fossil fuels produces nitrogen oxides. Both are precursors to acid rain. Still unknown is the effect of increasing the carbon dioxide in our atmosphere from all combustion of fossil fuels.

A third energy alternative is increased use of nuclear-fission energy, which incidentally increases the use of electricity. Public concern over diverse issues, such as perceived safety problems and possible indirect proliferation of nuclear weapon materials, has also put this option on hold. Further, sensitized by many unfortunate chemical-waste problems, the public is far from willing to accept current nuclear waste disposal proposals.

Nuclear fusion, still too young to reveal many of its possible societal problems—and as yet technically unproven—is nevertheless a major, perhaps *the* major promise of things to come in the next century. It is not as glamorous as information processing and biotechnology, but if it succeeds, fusion will provide the energy base to do all the more exciting things the 21st century human mind can imagine. Without it, humankind will have a far greater adjustment to make than the conservation "fix" made by the Western World in the late 20th century.

The Information Age

We have dwelled on energy, albeit with only a few examples, because of its fundamental role in our technological society. The more obvious technical revolution in which all of us are involved is the explosive growth of the "information age."

A decade ago, word processing was about to change the business office forever. But it has leaped far beyond, even into the home, where microcomputers have become commonplace. Tentative efforts in the past to investigate artificial intelligence are now becoming respectable pursuits, and we may not be far from having the next leap forward—what I have called "idea processing." A related element of this is already in practice: machine-guided decision making in medical diagnostics. Pattern analysis for weather and military uses is also in early practice.

The leverage of the computer as used in practice and thought is awesome. Computer-integrated manufacturing is already in place in some industries, and its effects on our society are only now being perceived. Computer-assisted education, however, is being developed more cautiously. Perhaps there is irony in the greater conservatism among educators, but surely within a generation the sum of technologies of the "information age" will have permeated industry, banking, business, education, and home life in ways still unimagined. Because of this, "the information age" may be the most appropriate descriptor of the nature of our immediate future technological society.

It is hard to imagine something as innocent as information processing causing problems. And yet, it seems that the mischief in the human brain is fully transportable to machines. Invasion of privacy, pilferage of proprietary information, replacement of human-craft jobs with microprocessor-controlled robots, and possibly just plain weariness in the "noise" of too much information are a few examples.

The Bio Revolution

Just as major changes have been brought about by information processing in banking and business, biotechnology may be on the verge of revolutionizing the agriculture, pharmaceuticals, and chemicals industries. It is ironic that fermentation is one of the oldest practices of life on earth, perhaps 2 billion years old; yet it is part of the latest biotechnology process scene. A giant step forward in this field began with the revelation of the structures of DNA and the chemical/physical nature of the myriad molecules in living matter. This is surely one of the most exciting developments of modern science.

As this work passes into the hands of technologists, we can foresee still more miracles in preventative and curative medicine, control of food plants through genetic engineering, and new ways to make chemicals from biomass. But again, this technology has engendered public fears not unlike those caused by nuclear technology.

Early on, there was concern that tampering with living molecules could release uncontrollable pathogens into the environment. It is reported that biochemical weapons are now being produced. We are reminded of Eiseley's (1969) book, *The Unexpected Universe* and his warning that solutions to problems often create still other problems. (His prime example was the population explosion that came as a result of sanitary engineering.) Biotechnology, so close to nature, may in the end have the greatest effect on the nature of our technological society.

Conclusion

These three areas of technology—energy, information, and bio—illustrate something of the nature of technology in our society. It is at once explosive, unpredictable, remarkably beneficent, and laden with social and technical problems. It forces us to accommodate its vagaries and to be flexible, if we are to share its bounty.

In its modern garb, technology may be too new on the human scene to be fully understood. Nevertheless, it is the responsibility of education, beginning in

the K–12 programs, to acquaint all members of our society with some measure of its technics, including hands-on practice. And of equal importance, education must deal with the social and political consequences of technology, both as history and future. Technology education in this holistic sense has an unprecedented challenge!

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A Progression of Technology in Industrial Arts Education

Kenneth Phillips

It is very difficult, in a short statement, to present a sense of the history of industrial arts/technology education. It is important, however, that broad areas be introduced.

Early times are discussed to illustrate how important hand skills were to the survival of primitive society and how they contributed to the refinement of civilization. The problem of the split between "theory" and "practice" in education is introduced as a critical development of the Grecian period.

The Middle Ages saw the Reformation, and with it emerged great interest in education for all children and the inclusion of manual activity as part of the instructional process. These beginnings paved the way for an organized method of teaching hand skills as part of the educational system.

As other countries in the world extended their concern for education for all citizens and the inclusion of activity programs emphasizing hand skills into the educational system, the United States was stimulated into action by the work of DellaVos of Russia and by the Sloyd system of Scandinavia. *American Beginnings* describes the evolution of manual training, manual arts, and industrial arts. *After World War II* describes the extensive curriculum development that occurred after the war. *A Curriculum to Reflect Technology*, presented at the annual conference of the American Industrial Arts Association in 1947, is featured for it is the first of the new curriculum efforts.

Additional curriculum concepts are also introduced as part of the final discussion. Finally, some common elements of the new industrial arts/technology are listed. The closing statement follows as a listing of *Important Points To Be Considered*.

Early Times

In early times, the "skills of the hand" were passed from generation to generation *by imitation* from father to son or from one individual to another by working together in a close relationship. Each primitive group was responsible for the well-being and support of the group.

As we learned to control and use fire and simple tools, some division of labor within groups developed. Some groups became skilled in a particular craft, and a form of group specialization developed. Instruction in skills continued to be passed on through imitation.

Early humans appreciated and respected the place and value of hand skills in their culture. These skills were the technology of the time. The laws of the group, and often their religious teachings, required that every young man be taught hand skills and a craft and be required to contribute to the group through his skills. Social and religious leaders were noted and respected for their hand skills.

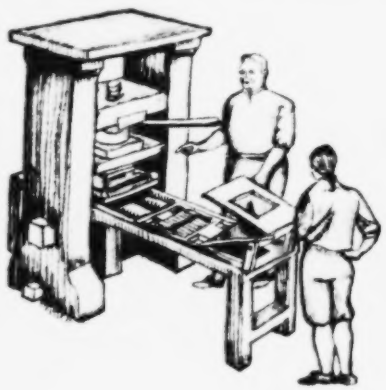
In the Homeric age of Greece, hand skills were respected. But as the Greek society became a slave economy, working with one's hands became *banausic* (a word indicating a contempt that cannot be expressed in the translation). Free men were "above" working with their hands, and they looked with contempt on the craftsman.

The significance of this short review of early times in relation to the passing on of hand skills is that no organized form of educational system existed other than that of careful imitation. The second significant consideration is the evolution of the Greek society into a slave economy, which established the schism between "academic or abstract education" and "applied or technological education." This strongly held prejudice against hand work, which emerged from the attitudes of the free men of Grecian times, has created an educational atmosphere with which every age and every country has had to contend. Good education, to meet the challenge of technology, will also have to contend with this prejudice and seek balance and understanding.

This schism must be considered as our profession discusses and plans new approaches, concepts, and emphases for an education system that better interprets modern technology. Plans should be made to better meet the questioning of the academics.

The Middle Ages

As civilization moved into the Middle Ages, the nobility and religious leaders were the dominant social groups with formal education committed to the development of the skills of politics and religion. These dominant groups shaped the organization of education and established Classical Education as the approach to education as "real education or liberal education." The teaching of hand skills, crafts and "work" was relegated to an



apprenticeship system. The apprenticeship system became the educational system of the working class.

With new developing technologies (such as movable type and the printing press), an increase in the wealth of the working class, and a rise in social reformation, a group of social and educational writers emerged. Bacon, Comenius, Locke, Rousseau, Pestalozzi, and Froebel were some of the more important authors of this time of rethinking educational philosophy.

Martin Luther advocated education for all children, and the educational writers introduced the concept of instructional activity as an important part of education. They proposed "manual arts" and the teaching of hand skills as a vital part of the students' educational experience.

The schools, the educational movements, and thought of this period paved the way for the later development of strong activity programs in education. The Russian System of skill training and the Sloyd Movement emerged soon after this period. These approaches to the teaching of hand skills, activity as an important part of the instructional process, and the Russian System and Sloyd Movement—all had a great impact on the American development of practical education.

American Beginnings

At the Philadelphia Centennial Exposition in 1876, an exhibit of the work of Victor DellaVos of the Russian Imperial Technical School of Moscow attracted the attention of American educators. The exhibit consisted of a series of exercise pieces in wood and metal. This series of exercises, for the first time, introduced an organized systematic system of teaching hand skills.

To several prominent educators, Rumble, and Woodward, this display seemed to answer the need for an organized program of shop work. Rumble adapted the Russian System of manual training into the School of Mechanic Arts of Massachusetts Institute of Technology (MIT) in 1877, and Woodward opened his Manual Training High School of Washington University in St. Louis in 1879. Rumble and Woodward promoted the concept of manual training as part of the general education of all youth. The establishment of a secondary school offering a sequence of courses including instrumental drawing, woodwork, patternmaking, foundry, forging, and machine shop in addition to courses in English, mathematics, science, history, and literature was soon widely copied.

Manual training high schools supported at public expense were opened in Baltimore in 1884, in Philadelphia and Toledo in 1885, and in other cities and towns across the nation. High schools bearing the names technical, polytechnic, and mechanic arts were also established. Their curricula and equipment were quite similar to the St. Louis Manual Training School pattern, although from time to time new shop areas were added to keep abreast of changing and expanding industry. Shop work became accepted as a subject field in the general high school curriculum shortly after the turn of the century.

The first real impetus to the introduction of manual training in the elementary schools (K–8) came in 1888 in Boston with the arrival of Gustaf Larsson, a leader in the Sloyd teacher education movement. He was followed soon after by Charles A. Kunou and Josef Sandberg. The work of these educators was financed by private funds.

Almost immediately upon arrival, Larsson began teaching a private summer school class in a type of training called Swedish Sloyd and a few months later was giving instruction to public school teachers. The greatest contribution Larsson and his associates made was in the area of teacher education. The Sloyd Training School in Boston, established in 1890, gave instruction to teachers from all sections of the nation. The teachers trained in this school were greatly responsible for the rapid growth of manual training, especially in the elementary schools.

Unlike the exercise work practiced in the St. Louis Manual Training School, the Sloyd System of manual training gave the student an opportunity to construct a series of useful articles. The articles were arranged in progressive order of difficulty. After a few years of change and adjustment occasioned by the differing needs of American youth, these two European systems of instruction became a part of the uniquely American manual training program.

As time passed and as thinking and methods matured, the manual training movement went through some changes (late 1800s). A trade and industrial vocational education movement for the secondary level developed in the late 1800s and early 1900s. At the same time, a manual arts movement was emerging. The trade and industrial vocational education movement depended more on the Russian System and its approach to skill training. The manual arts movement grew out of the Sloyd System and the arts and crafts movement emerging in England. In the manual arts movement, emphasis was both on skill and the making of useful and well-designed objects.

The late 1800s and the early 1900s were periods of change and ferment in the profession. Undoubtedly, sharply drawn positions were taken, and intense discussion was part of every professional meeting of manual training, vocational education, and manual arts proponents.

The manual training profession was struggling with the problems of future directions of their programs. John Dewey published *The School and Society*, which was a major catalyst for further reexamination and change in the manual arts movement. Dewey placed the study of industry and the social implications of the industrial culture as central to the educational process. This concept was referred to by Richards, Russell, Bouser, and others as "industrial arts" and was the inception of the industrial arts movement.

It is interesting to note the problem of the profession, with the manual training movement now developing in several major ways. Trade and industrial vocational education was emerging as a major education program with the passage of the Smith-Hughes Act of 1917–18. Industrial arts was gaining broad acceptance, particularly at the seventh-, eighth-, and ninth-grade levels.

What would the profession be like today if there had been more cooperative effort among the professional leadership? The competition was severe between the vocational leadership and the industrial arts leadership. Within the industrial arts group there were some who believed that industrial arts should be prevocational in its emphasis; others believed it should be broadly conceived and interpret the industrial culture as an important part of general education.

Between World War I and II, the industrial arts profession could not clearly focus on common objectives and common terminology to describe programs, activities, and types of shop organization. Several efforts were made to bring the profession together. In 1934, the American Vocational Association (AVA) released *Standards of Attainment in Industrial Arts Teaching*, an effort under the leadership of Robert W. Selvidge that emphasized the prevocational aspects of the program.

In 1938, the United States Bureau of Education published *Industrial Arts: Its Interpretation in American Schools*. William E. Warner and Lois C. Mossman, who represented the broad general education approach, had much influence on this

report. The industrial arts leadership, in 1939, representing the broad general education leadership group, organized the American Industrial Arts Association. AVA had, in 1932, organized an Industrial Arts Division.

It is evident that the industrial arts profession has not been able to solve the problem of the prevocational approach versus the broad general education approach. Perhaps as the profession evolves, a new concept to meet the challenge of the emerging technology can help the entire profession reach a common agreement.

After World War II

The period after World War II was marked by phenomenal efforts in curriculum study, reports, and recommendations. The first curriculum proposal was developed during the years 1946 and 1947, under the direction of William E. Warner and a group of his graduate students at Ohio State University. It was developed as a presentation for the American Industrial Arts Association's first annual conference after World War II in Columbus, Ohio. This curriculum concept was called *A Curriculum To Reflect Technology*. The outline of the major sections of this curriculum proposal is included here because so much of the curriculum effort that followed was strongly influenced by this curriculum concept.

The Management Organization

The effective development of the industrial arts/technology program requires that the time and effort of every participant be well organized just as in any complex enterprise. This is possible through the establishment of a personnel management organization within the laboratory.

This section is then organized under the following heads:

The Need for Organization

Types of Organization
1. Line
2. Functional
3. Committee
4. Multiple
5. Line and Staff

A Proposal Personnel Organization
1. Organization Chart
2. Job Specification Index
3. Cumulative Personnel Record Card
4. Activities Chart or Record

Application to a Teaching Situation

A Curriculum To Reflect Technology introduced the five areas of curriculum: communications, construction, power, transportation, and manufacturing. Other curriculum studies adapted these titles for their own use and suggested different approaches for program activity. In 1950, Delmar Olson's dissertation, *Technology and Industrial Arts*, recommended that the subject matter for industrial arts should be developed from the technology of industry. Olson completed his dissertation under Warner's direction. Gordon O. Wilber completed his book, *Industrial Arts in General Education*, in 1948. Even though it was a more conservative approach, it was broadly adopted in teacher education programs. Wilber wrote a new definition of industrial arts and proposed a program emphasis concerned with the changes of student behavior through the instruction and activities of the industrial arts shop areas. In 1953, AVA published a revised edition of its booklet on industrial arts, called *A Guide to Improving Instruction in Industrial Arts*.

Other curriculum developments were also taking place, and the industrial arts profession was working on a broad range of program ideas. Mass production as a unit of instruction, the organization and development of a company to design and produce a product, and the development of a business structure, similar to the Junior Achievement idea, were all used as program concepts.

More science and mathematical relationships with student activities were

A Curriculum To Reflect Technology

I. THE COMMUNICATIONS DIVISION

Composition & Duplication	Transmission & Reception	Interpretation
Graphic Arts-Sound Recording	Mechanical-Electrical	Visual, Sound & Codes
Drawing, Sketching	Telegraphy	Historical
Drafting, Blueprinting	Telephone	Signal Flags
Letterpress	Radio (CW, MOD)	Lights
Photography	Teletype	Sound Devices
Intagliography	Facsimile	
Planography	Television	
Duplicating	Multi-Channel Methods	
Sound Recording	Radar	

II. THE CONSTRUCTION DIVISION

Homes
Highways, Including Bridges & Tunnels
Factories and Public Buildings
Airports
Waterways
Single fabrication, housing, public works, industrial, national defense . . .

III. THE POWER DIVISION

Sources	Natural, Electrical, Thermal
Generation	Solar, Hydro, Biological, Combustion, Nuclear Fission, Electrical
Transmission	Hydraulic, Pneumatic, Mechanical, Electrical
Utilization	Manufacture, Construction, Transportation, Communications

IV. THE TRANSPORTATION DIVISION

Land	Highways, Railroads
Air	Heavier than air, Lighter than air, Navigation, Meteorology, Airports, Aerodynamics, Space
Sea	History, Carrier types, Ship construction, Power plants, Propulsion units, Small boat building, Model making, Terminals, Routes, Organization, Documents

V. THE MANUFACTURING DIVISION

Major Areas	Food, Textile, Rubber, Chemical, Cellulose Fiber, Leather, Metal, Ceramic, Miscellaneous
Areas of Study	History, Materials, Fabrication, Consumption, Applications

developed by another group. Donald Maley of the University of Maryland was a leader in this effort, proposing student activities organized around investigation, exploration, analysis, testing, and the use of tools and materials to solve problems. Some states developed their own unique state plan for the improvement of industrial arts.

The 1960s saw a continuation of additional curriculum studies. The American Industry Project analyzed the full spectrum of American industry to establish a conceptual framework for program activities. Excellent instructional materials were developed. Another example of outstanding curriculum development was the Industrial Arts Curriculum Project (IACP), centered at Ohio State under the direction of Donald Lux and Willis Ray. Two major courses made up the program subject matter: The World of Construction was the first-year course, and The World of Manufacturing was the second-year course. The instructional materials for these courses were tested over a four-year period and then made available commercially.

Other approaches to curriculum development were also made in many parts of the country. A wealth of materials is available; however, a professional effort of the leadership should be made to organize it into the context of teaching American technology. A common approach to teaching a technology program should be developed with enough flexibility provided to allow local interests and concerns to be met. Some common elements of the new industrial arts/technology follow:

- It should be an activity program.
- It should be taught to all boys and girls.
- It should orient young people to the challenges, responsibilities, and opportunities of the technological age.
- It should be a broad approach and include a variety of technological concepts and experiences.
- It should be a *bridge* between "academic skills" and "practice" and between "theory" and "operation."
- It should provide an opportunity for young people to determine their own aptitudes and interests in a practical way.

These common elements and others would be considered as permanent objectives wherever the technology program is developed and offered. Local emphasis or organization would be considered to illustrate, support, and enhance the common elements of the program.

Recommendations

A review of the history of hand skill development, manual training, manual arts, industrial arts, and now the challenge of technology indicates that change occurs and is most logical and appropriate in times of ferment and change. Education today is in ferment and changes are being made. It is most critical that the industrial arts/technology education profession draw on its rich history and wealth of curriculum materials to establish a program that can explore, explain, and use the modern American technology. Some important points to consider are listed below:

1. Learn from the lessons of history and past experience.
2. Change must be a national effort coordinated throughout the profession.
3. The profession must participate in and understand the change process.
4. Developmental views and opinions must be brought together so cooperation and mutual support can be accomplished.
5. Identify and emphasize common elements and strengths of any national proposals for programs.
6. Do not emphasize program differences.
7. Organize and recruit the support of the entire profession.
8. The program must act as the *bridge* between academic understandings and the practical application of principles.
9. Change is often resisted by the professionals and must be considered.
10. Change must be evolutionary to be successful in a profession.
11. Reexamine and harness some of the career education concepts for the benefit of the emerging technology program concepts.
12. Strong assistance to teachers in the field in making the transition effort is essential.
13. Develop learning and teaching guidance and resources for the new program.
14. Develop and suggest suitable student activities for implementing new program concepts.
15. Publicize the incorporation of the latest technology concepts (e.g., robotics and computers) into student activities.
16. Develop guiding principles for equipment selection and facility reorganization.
17. Encourage a renewed interest in the use and values of self-instructional techniques and materials.
18. Determine early what each segment of the profession's role will be in the transition and gain commitments.
19. As vocational education becomes increasingly interested in a more general approach, more points of common interest and support must be developed.
20. Expect the professional associations to organize and rally the leadership for the future.
21. Examine the professional associations' Programs of Work for ideas and guidance in establishing an action program.
22. Plan well, coordinate, and publicize the professional developmental efforts.
23. Understand and use good principles of marketing, promotion, and information distribution both inside and outside the profession to expedite the concept of change.

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Technology Education: An International Perspective

Ronald D. Todd

This article presents a conceptual framework that should be helpful in determining the status and development of technology education from an international perspective. The framework is founded on some basic propositions about technology and education.

The framework's basic underlying proposition is that all countries go through an evolution of technological growth and development. Each country will have unique growth patterns, but all will go through some common phases of development. A country may adopt a specific technological innovation, such as nuclear energy, by patterning more advanced countries through a process called "mimicry." But, mimicking an instance of technology does not mean the country has reached a significantly new and advanced level of technological development. The efforts of technology transfer in the 1950s underscored dramatically the proposition that developing countries must labor through a cumulative process of technological evolution (Pytlik, 1983).

A second proposition undergirding the framework is that the technology education of a country closely reflects its technology. The educational institutions do not transcend, in any significant manner, the current level of a country's technological development. Schools and other educational agencies reflect and attend to the interests and needs of their country. If a country has made a commitment to expand its industrial base and consequently strives to secure new industries and strengthen existing industries, the technology education of that country will respond, however slowly, to issues relating to enhancing industrialization. Little attention will be given to higher level issues and consequences until a country has reached a higher level of technological development.

Levels of Technological Development

Countries tend to move through several levels of growth in their technological development (Pytlik, 1978). The framework presented here has five levels, starting with lowest level or *indigenous*, and moving through the *emerging*, *developing*, *industrialized*, and finally to the *cybernetic* level.

At present, few countries have attained the fifth level of development, variously called *postindustrial* (Bell, 1973), *information-based* (Evans, 1979), and *third wave* (Toffler, 1980). The term selected here is *cybernetic*, indicating both the importance of communications and the integration of earlier, distinct technological systems.

Few countries will exist at a single level of technological development. Many countries may straddle two or more levels of development or have regions within its boundaries representing different levels of technological development. The United States could be viewed as a well-established industrialized country and as a new cybernetic nation, yet some parts of the country show vestiges of earlier levels. (McRobie, 1981).

The five levels of development are shown in graphic form in Figure 1.

Technology and Education

How a nation views technology education will be directly related to how it views technology. The country's level of technological development plays a significant role in shaping the meaning given by that nation to technology. Consequently, the operational definitions of technology differ tremendously and range from (a) tools and hardware; (b) production of goods and services; (c) systems of construction, transportation, communication, and production; (d) a body of knowledge of practical value; to (e) a philosophy of thinking and doing.

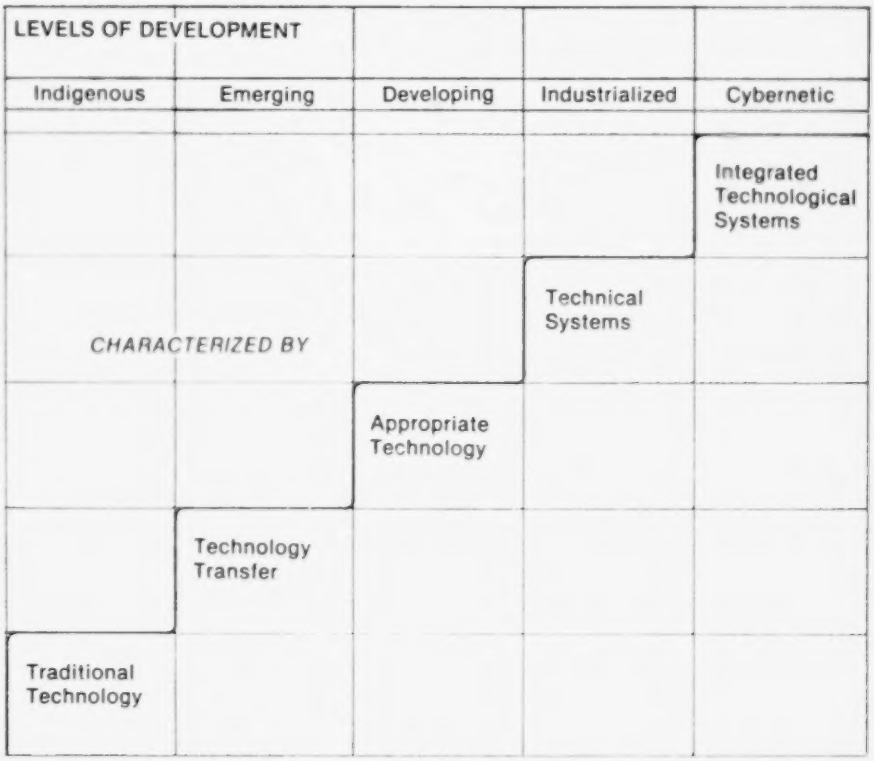

Figure 1
Levels of Current Technological Development

Logically, it follows that technology education will have as many different meanings as does technology, and the meanings change to fit the setting, use, and level of technology of a given country. Thus, we encounter some real problems in stipulating a single definition for technology education and in discussing the concept in a manner that reflects the real diversity that exists. The approach used here to deal with these problems of ambiguity is to superimpose a framework as a "structure of meaning." This framework can provide conceptual handholds on this topic.

The conceptual framework used here is an extension of the work of Deforge (1972) as he attempted to identify common aspects of technology education throughout Europe. The three major components Deforge included in his framework are (a) the purposes of technology education, (b) the forms of teaching, and (c) the degree to which the study was interdisciplinary. I have added another component: how technology is viewed by a given country. Figure 2 is a graphic presentation of the modified conceptual framework.

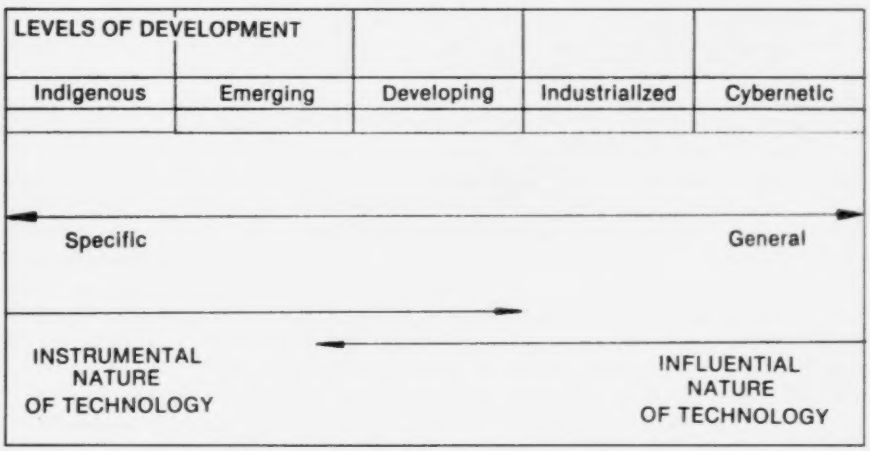

Figure 2
The Purposes of Education

Indigenous: Traditional Technology

At the lowest level of technological development, countries are limited to the technology that exists in that society and region. All societies have evolved a technology that is an integral part of that society. This basic level of technology represents what is needed to keep the country operating in its current form and structure. A new term, *traditional technology*, describes the technology indigenous to a specific area, country, or culture. The concept has only recently been studied in regard to its general usefulness (*Traditional Technology*, 1980).

Countries with a level of technological development of an indigenous or traditional type tend to derive economic benefit from exports of its natural resources or its agricultural products. Finished products are usually limited to the work of crafters and artisans and represent only a very small percentage of a nation's trade. Except for nomadic cultures, no nation seems content to remain at the indigenous level.

Emerging: Transfer of Technology

Many countries have grown beyond a complete dependence on an indigenous technology and have reached the "emerging" level of the technological development hierarchy. Countries at this level become heavily involved in the transfer of technology from outside their boundaries, usually from developing and industrialized countries.

Transfer of technology dominated the international thinking of the 1950s and 1960s. The promise of worldwide prosperity evaporated in the harsh light of reality, despite the investment of tremendous amounts of money. Changing a nation's economy is more complex than the quick and easy solution envisioned by technology transfer. Technology transfer still holds considerable promise provided it is used with far more cultural and technological insight and sensitivity than were applied in the past.

The Purposes of Education

Deforge proposed that technical education attempted to fulfill three purposes:

1. to facilitate observation of students, either individually or in teams, faced with a specific problem requiring them to dismantle, reassemble, and create objects of their own design.
2. to promote guidance, particularly toward technical and scientific education, by arousing positive motivation.
3. to give both boys and girls the tools to understand the environment in which they live; an introduction to technology, interpreting diagrams, methodology, and the organization of work. (Council of Europe, 1972)

To these should be added the following purpose:

4. to provide students with the setting to make technological decisions and to study the effects of those decisions from personal, environmental, social, and cultural perspectives.

The four purposes of technology education within the formal system of schooling are shaped by the social, human, psychological, and educational considerations. These purposes include the following:

1. **Technology and social–cultural education**: the polytechnical (multidisciplinary) approach. To achieve this purpose, schools should not be cut off from the outside world and particularly not from the world of work. Polytechnical (multidisciplinary) education is intended to help students identify how they might fit within a particular social system by ensuring that they have contacts with people of all kinds who work with or are affected by technology. Appropriate learning activities would include environmental and futures studies.

2. **Technology and people:** group work. This intended purpose is to engage the student in work as a part of a group rather than focus on a particular society. In this approach, the students find their places in the group according to their abilities, ambitions, and knowledge. The mass production of a product or the conduct of a

student enterprise would be appropriate for this purpose.

3. **Technology and the interdisciplinary concept:** application and synthesis. This purpose requires that students draw on and integrate different technological subjects. The project method is particularly well suited to this purpose because it makes the study of a technical problem the center of interest to which the other subjects contribute both practical skills and information. The intended direction is toward synthesis and practicality. Student research and development problems or individual study projects are appropriate to this purpose.

Developing: Appropriate Technology

As a country grows and matures in the use of technology transferred from other countries, new questions are asked. Specifically, the issues focus on the appropriateness of the technology that is being accepted from without (Ndongko & Anyang, 1981). *Appropriate technology* is the most commonly used term to describe this approach to the critical assessment of technology. Although the concept has been linked closely with "intermediate" technology, "village" technology, and the "small-is-beautiful" approach, appropriate technology is most useful when applied as a procedure of decision making rather than as a philosophical position on what is acceptable or desirable.

The appropriate-technology approach provides alternatives to bipolar, either–or thinking. One need not accept that bigger is better or that small is beautiful but can search for other intermediate solutions to technical problems (Darrow & Pam, 1978). For example, education has been identified as a workable means for encouraging agricultural development throughout Africa. The delivery of that education, however, could use both big and small approaches (e.g., satellites or tutorial) (Dubin, 1976).

Appropriate-technology approaches also have drawbacks. One is the view of some developing countries that appropriate technology is a lower and inferior form of technology. This perspective is intensified because much of the appropriate technology currently in use is directly related to rediscovered secrets of a past and historic technology of more advanced countries ("Appropriate Technology," 1982).

Industrialized: Mass Production

Industrialized countries are far fewer in number than those that fall within the above categories. Industrialized countries include nations that are able to provide most of the products and services required for their people to maintain a relatively high standard of living. Industrialized nations are also the mass producers and exporters of products for the rest of the world. Considerable importance is placed on the manufacture of hard goods that are in demand worldwide. Leadership in technology is currently equated with the capability of a country to mass produce and distribute those hard goods.

Unfortunately, countries at this level, in their drive for industrialization, often gravitate toward the big-is-better approaches to production. A strong economic system is equated with large production systems. These systems, in turn, require a large supportive infrastructure of other technological systems for transportation and communication.

Industrialization is often the long-range goal of countries at lower levels of development. For example, the People's Republic of China has recognized the need to gain control over science and technology as the major step toward contemporary systems of agriculture, industry, and defense (Schneider, 1981).

Cybernetic: Postindustrial

The cybernetic level of technological development is quite new. This level has an existing economic base, not only in large industries that produce goods, but also in electronic, service, and communication industries that provide machines and systems that process, transmit, and provide information to others. Typical products are computers, robots, and satellites. Only a small number of countries have taken the first tentative steps into this level. All of these countries—the United States, England, France, Japan, and Germany—are currently straddling the threshold between the industrialized and postindustrialized levels.

4. **Technology and disciplinarity:** the analytical approach. In this purpose, subjects retain their traditional separation. Individual subjects are studied for their own value. The application of the knowledge is usually made to problems within the discrete subjects both inside and outside the school. The study of electronics as a separate subject is appropriate here.

At least one additional purpose could be included as a logical extension to this sequence. The purpose would focus on the development of tool skills in their own right and would move toward more intensive technical training. Such training may be viewed as a lower level technology education as described in more detail in the following paragraphs.

The Forms of Teaching

The interdisciplinary concept as it relates to the teaching of technology helps to identify and distinguish between six different forms of technical teaching. These forms range from specific skills to an educational outlook shaped by a philosophy of technology and include the following:

1. **Technology as a set of skills.** This form of teaching places a premium on the acquisition of craft and tool skills. For

example, students would be helped to learn how to use a variety of wood technology tools and machines.

2. **Technology as a form of motivation.** This form of teaching uses the power of hands-on and project activities to interest students in studying a specific subject. Math and science make use of technology as a motivational device to help students remain engaged in the study of those subjects. For example, students may be allowed to build a wooden model of a structure to help them understand real structures or to make measurement and calculation more interesting.

3. **Technology as a subject in its own right.** In this form, technology courses are scheduled separately and little attention is given to establish links with other subjects. Students could take separate subjects in wood technology, design, and strength of materials and not necessarily have the opportunity to apply them to a common problem.

4. **Technology as an end in itself.** This form of teaching could involve students in higher level subjects that integrate several discrete courses already completed by the student. This form could also provide students with the opportunity to study a general area of technology and then set out to learn important related skills and knowledge. For example, students could study construction to apply what they had previously learned or to find out that they need to learn.

5. **Technology as a guiding theme.** Teaching of this form starts with a technological theme, such as architecture of shelter, and develops a spectrum of content that relates to the theme. Advanced instances of this form would make little use of discrete subjects and time-dictated schedules (Deforge, 1972).

6. **Technology as a philosophical perspective.** This form of teaching is shaped by an outlook that views technology as a set of higher level problem-solving skills. This philosophical perspective proposes that there is a technological equivalent to the "scientific method." Students using the "technological method" related to structures and shelter would engage in a process that places a premium on identifying alternatives to problems and making trade-offs while attempting to find optimal solutions to their problems.

The Technology Continuum

The diagram presented in Figure 3 identifies a perspective of technology that ranges along a continuum from the specific to the general. The specific direction of the continuum places primary importance on the "instrumental" nature of technology or how it can be put to practical use. The general direction of the continuum places importance on the global nature of technological impacts. Attention in this sense is given to the results and consequences of technology.

At the indigenous level of development, the educational focus is instrumental in nature. This is understandable because most countries at this level are faced with the pressing problem of providing basic needs for their people. Consequently, a nation will not have the time or other resources to shift its educational attention much beyond the immediate problems of feeding, housing, and caring for its people. Most activities in agriculture and industry will be at the subsistence level, and the supportive technical systems will usually be rudimentary and informal.

Most nations at this level will have systems of schooling that provide only basic education for a few people. A system with more than token technical courses will be unusual. Education at this level is largely provided through informal methods. The most common is for older workers with a technical skill to take on one or more young workers as assistants. Through a long period of involvement and observation, the young accumulate the skills and knowledge of the old.

Emerging countries that are attempting to transfer the technology of another country find that a more formal approach to training is necessary. The products and devices used and constructed through the educational efforts will often look like a "time warp" in the history of technology.

Countries at the developing level have accumulated considerable experience in both the successes and failures of technological transfer. This experience allows them to provide training that asks questions on the appropriateness of the technology to be transferred. Concern can, therefore, be shifted beyond the specifics of technology to the purposes its use may achieve and the effects that specific technological instances may have on individuals, a group, or a society. Questions of this type can only be posed with information from the country's technological history and from the experiences of other countries.

Education in an industrialized country takes on more technical aspects with an increased emphasis on such technical fields as mechanics, pneumatics, hydraulics, and electronics. The educational system strives to supply trained workers who can keep, maintain, and expand the production industries. These industries are the ones that form the basis of the wealth of that

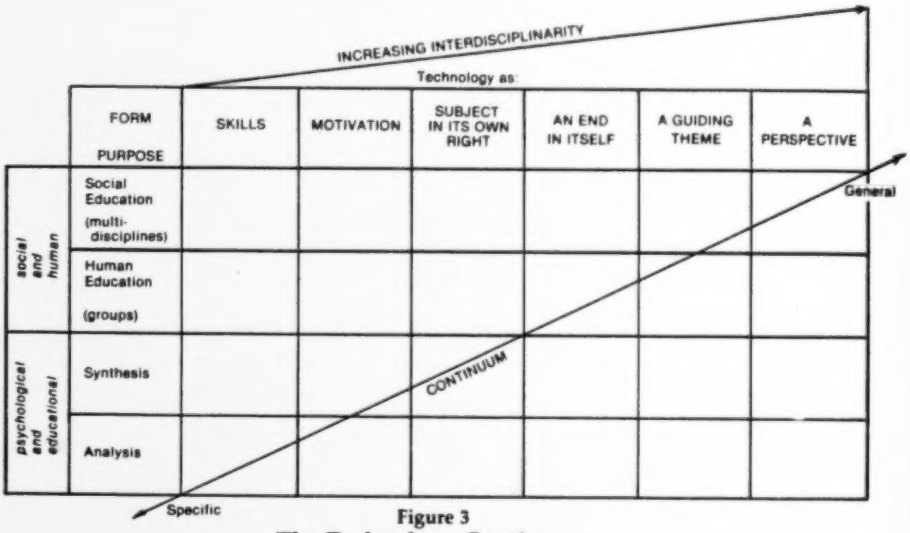

Figure 3
The Technology Continuum

particular country. Educational programs tend toward areas of specialization to provide the in-depth skills and knowledge required for a given technical system. The educational system, therefore, will see a significant increase in vocational and technical programs as the country develops more areas of industrialization. Specialization is both the strength and weakness of this level of development.

The educational profile of postindustrial countries is still rather vague. Because no country has really achieved a predominately cybernetic status, one can only guess at what technology education will become. Yet, it is possible to identify directions and trends. Higher level technical training will supplant the more standard vocationally oriented training of the industrial era. The hallmark of technology education at this level of development will be the integration of many discrete subjects into new, broader, and more powerful subject areas.

Technology Education and Its Impacts

As a country's view of technology moves toward a global concern, more educational attention is given to the potential consequences and impacts of technology. The focus is on the consequences or impacts that technology will have on the individual, the society, or the ecology. The interest in consequences seems to increase as a nation becomes more advanced, and hopefully more mature, in its use of technology. At the indigenous level, there is little concern for impacts because the technology in use is survival oriented and has usually evolved over a long period and thus has limited spheres of undesired influence and impact.

The problems of impacts begin to change as a nation enters the emerging level. With the transfer of technological innovations from other countries comes educational problems, or preparing people to determine the suitability of those innovations to the area, the people, and the society in which the changes will be implemented. The question of consequences will be tied rather directly to instrumental questions of how well the innovations will work. Concern for consequences at this level are usually after the fact. There are numerous examples, such as the attempted transfer of grain storage structures—successful in a country of similar climate—to a different country. Only after the crop was lost were questions asked as to the shortcomings of the grain storage units. The transfer of technology brings new meaning to the teaching of history.

As a country enters into the developing level, the demands on the educational system begin to grow. Questions on the appropriateness of a technological innovation need to be asked before its attempted transfer to a new setting and circumstances. Such question asking requires that the concern be considered before action is taken and the effects have run their course. In essence, this requires a futures-oriented training and perspective that considers impacts before events.

The transfer of technology brings new meaning to the teaching of history.

As the scope of potential impact of technology grows, the importance of such futures thinking and futures planning becomes more and more important. These skills, in turn, place increased importance on the role of education, especially the role of technology education. Each level becomes more and more complicated, and the questions become more and more demanding. The training required for this level places a premium on problem-solving skills.

Futures-oriented studies draw heavily on technology as a body of knowledge. The skills, knowledge, and procedures of technology are important if a person or nation is to identify trends and patterns that can be projected into the future. Much of this important understanding can grow out of the direct involvement, study, and problem solving in technology. Thus, additional importance is placed on the intrinsic value of technology. That value of technology in and for itself suggests that students should be given the opportunity to study technology because of its worth. The intrinsic perspective assumes that not all technological knowledge need be put to practical use for it to be of value. Obviously, such a perspective will emerge late in a nation's technological development.

Technology Education: An International Movement

While doing the research for this article, I was reminded again and again of a phrase from avant-garde cosmologists and science fiction writers: "We are not alone." In technology education, we certainly are not alone. In fact, as a profession we are relatively recent arrivals on the scene.

Technology education can be found in many different forms and levels of development. Its importance at all levels seems to be growing. In a recent article, Maley (1982) presented an overview of technology education in Europe. His work included a description of technology education in France, Greece, Italy, Spain, the United Kingdom, and West Germany. In an earlier article, Deforge (1972) described technology education as it is developing in the Soviet Union, Austria, Spain, Cyprus, Turkey, Portugal, Malta, Sweden, and Belgium. He also indicated that many French-speaking Black African countries, as well as Morocco and Tunisia, are now providing or plan to provide technical education.

Interest in technology education has indeed circled the world, as indicated by the theme of the Third International Conference of the Institute of Industrial Arts held in Suva, Fiji, in 1983. The participating countries included Australia, New Zealand, Fiji, Solomons, Keribati, Papua New Guinea, and Somoa. The theme of the conference, "Industrial Arts (Technology Education) at the Crossroads in the South Pacific—Which Way Now?", posed many of the same questions that have been asked at similar conferences in this country and in Europe ("Industrial Arts," 1984).

Of particular note is the growing interest internationally in technology education for all students, rather than just for the technically competent. As countries reach the end of their industrialization era, a number of forces take shape. National interest concerning the loss or impending loss of leadership in world production and trade increases. A dichotomy of innovation and conservatism regarding technology and progress emerges. Innovations are initiated to compete in the changing world market. At the same time, more conservative positions are often assumed by decision makers in an attempt to protect the current status and accomplishments. The social and technological fabric of the country appears to come apart at the seams because of the increasing and competing pressures.

Countries at this level of development tend to turn to education as both a scapegoat and as an agency to help cope with the growing problems. At this juncture in the evolution of a country, technology education receives unprecedented attention from several levels within the society. The importance of a technologically literate population becomes more apparent. Certainly, people who understand technology can help invent new products as

well as implement new technical systems to produce and distribute the products and services. On a more immediate basis, however, a technologically literate populace would be better prepared to consider proposed technological changes and their social impacts on a more rational basis.

Most of the countries around the world have taken some serious steps in their evolutionary process of technological development. Many, if not all, of these countries will face the same problems and commit the same mistakes made by countries more advanced in their technological development. It is not necessary, however, to repeat all the mistakes of the past if there is a cooperative sharing of the collective experience, knowledge, and insight regarding technology education. There is a great deal to be accomplished in elevating technology education along the scale of development; but remember, "We are not alone."

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Technology Education: A Direction for the Profession

Technology Education: *A comprehensive, action-based educational program concerned with technical means, their evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and their social/cultural impact.*

The school prepares youths for the world in which they live. Experiences are provided that uncover, develop, release, and realize individual potential.

Because the American culture is distinctly characterized as technological, it becomes the function of schools to give every student an insight and understanding of the technological nature of the culture. This is what the program of technology education strives to do. It acquaints all persons with their technological environment so they can make rational decisions about their own lives on a day-to-day basis and eagerly participate in controlling their own destiny.

Recognizing the individual's native potential for reasoning and problem solving, for imagining and creating, for constructing and expressing with tools and materials—from which technology and industry spring forth—technology education capitalizes on this rich potential and develops content and experiences to contribute to the growth and development of human beings commensurate with their potential. Thus, technology education is a basic and fundamental study for all persons, regardless of educational or career goal.

Technology education can help the student

- know and appreciate the importance of technology.
- apply tools, materials, processes, and technical concepts safely and efficiently.
- uncover and develop individual talents.
- apply problem-solving techniques.
- apply other school subjects.
- apply creative abilities.
- deal with forces that influence the future.
- adjust to the changing environment.
- become a wiser consumer.
- make informed career choices.

Criteria for a Technology Education Program

At all levels, the program/course content is based on

1. an organized set of concepts, processes, and systems that are uniquely technological.
2. fundamental knowledge about the development of technology and its effect on people, the environment, and culture.
3. instructional content drawn from one or more of the following areas:
   (a) *communication*—efficiently using resources to transfer information to extend human potential.
   (b) *construction*—efficiently using resources to build structures or constructed works on a site.
   (c) *manufacturing*—efficiently using resources to extract and convert raw/recycled materials into industrial and consumer goods.
   (d) *transportation*—efficiently using resources to obtain time and place utility and to attain and maintain direct physical contact and exchange among individuals and societal units through the movement of materials/goods and people.
4. assisting students in developing insight, understanding, and application of technological concepts, processes, and systems.
5. applying tools, materials, machines, processes, and technical concepts safely and efficiently.
6. developing student skills, creative abilities, positive self-concepts, and individual potentials in technology.
7. developing student problem-solving and decision-making abilities involving human and material resources, processes, and technological systems.
8. preparing students for lifelong learning in a technological society.

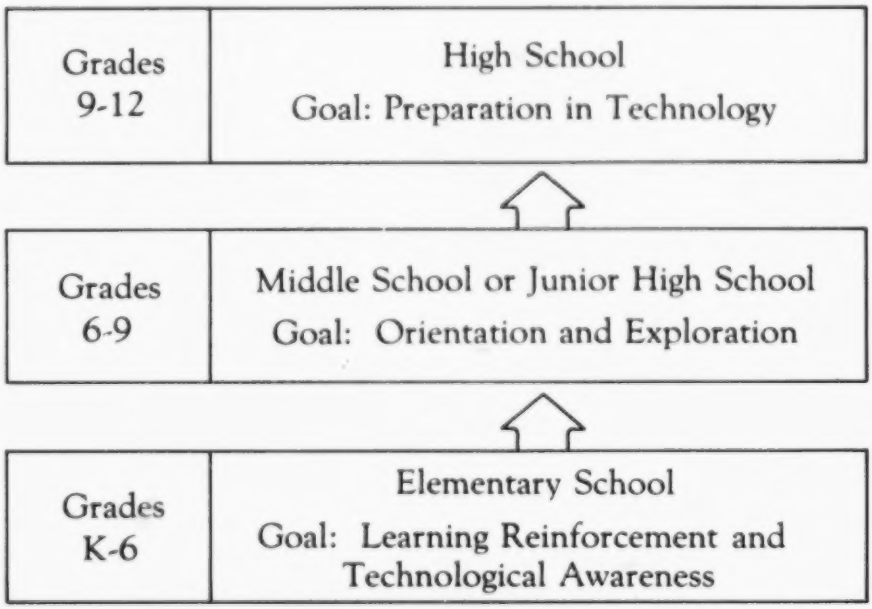


Figure 1
Curriculum Structure for Technology Education

9. activity-oriented laboratory instruction with students reinforcing abstract concepts with concrete experiences.
10. a combined emphasis on "know-how" and "ability to do" in carrying out technological work.

Curriculum Structure for Technology Education

Technology education should be implemented at all levels in the schools. Figure 1 shows a model for the curriculum structure for technology education.

At the elementary school level, grades K–6, the goal for technology education is learning reinforcement and technological awareness. Orientation and exploration are the goals for technology education at the middle school or junior high school, grades 6–9. The primary purpose of technology education at the high school, grades 9–12, is preparation in technology.

Technology Education at the Elementary School (Grades K–6)

Description

Elementary school technology education experiences are designed to assist in the attainment of educational goals of the total elementary school program. These experiences orient students to technology, develop personal psychomotor skills, and refine attitudes about technology's influence on society. The technology education program activities should be integrated into the total elementary school curriculum, and these activities should provide students with experiences that reinforce this curriculum.

Technology education at the elementary school

1. provides opportunities for children to learn fundamental concepts on how people create and control their environment.
2. reinforces and enriches concepts in the sciences, mathematics, language arts, and other subject areas in the elementary school curriculum.
3. allows students to work with tools, materials, and technological concepts and processes.
4. develops technological awareness.

Goal: Learning Reinforcement and Technological Awareness

The goal of technology education at the elementary school is to provide learning reinforcement that contributes to the pupil's personal development and technological awareness.

Suggestions for Implementation

Elementary school teachers should complete preservice or in-service training in technology education before integrating technology education into the existing elementary school curricular content. The technology education program is implemented in existing elementary school classrooms; however, additional tools, materials, and supplies must be provided to accommodate student needs and activity requirements.

Middle School or Junior High School Technology Education (Grades 6–9)

Description

The technology education program at the middle school or junior high school is exploratory in nature. At this level, students investigate and examine the four broad content areas of technology education, which are communication, construction, manufacturing, and transportation. It is recommended that all students take technology education at this level, whether they have future education plans to enter college or to pursue a vocation after high school and regardless of their career goals. Technology education courses at the middle school or junior high school level should be designed to lead into a well-articulated series of courses at senior high school and postsecondary levels.

As a result of taking technology education at the middle school or junior high school level, all students can begin to develop their innate talents, attitudes, and skills to better live in our technological world. Problem solving, career orientation, and learning for tomorrow's adaptive environment are cornerstones of the technology education program at the middle school or junior high school.

As a result of taking technology education, students will

1. appreciate the scope of contemporary technology.
2. safely use basic tools, machines, materials, and processes associated with technology.
3. identify occupational fields and educational programs in technological career fields. Study and analyze the materials, products, processes, problems, uses, developments, and contributions of these related career fields.
4. experience the organization and management systems of business and industry.
5. research, plan, design, construct, and evaluate problems and projects common to technological career fields.

Goal: Orientation and Exploration

The goal of the middle school or junior high school technology education program is to assist students in making informed and meaningful educational and occupational choices.

Standards for Middle School or Junior High School Technology Education Programs

For the establishment, operation, and assessment of quality programs in technology education, it is recommended that the *Standards for Technology Education Programs* be used. Contact AIAA for information on the purchase of these Standards.

GRADES	RECOMMENDED COURSES	TYPE OF COURSE
8-9	Communication Systems Construction Systems Manufacturing Systems Transportation Systems	Elective courses, each a semester in length.
6-7	Introduction to Industrial and Technological Systems	Required course, a semester for all students

Figure 2
Recommended Courses in Technology Education for the Middle School or Junior High School

GRADES	COURSE	TYPE OF COURSE
9-12	**Communication:** Graphic Communications Systems Electronic Communications Systems Media Communications Systems	Elective Courses one or two semesters in length
	Construction: Construction Planning & Design Constructing & Servicing Structures Electro/Mechanical Systems & Servicing	
	Manufacturing: Manufacturing Materials & Processes Designing Products for Manufacture Manufacturing Production Systems	
	Transportation: Technical Elements Transportation Planning & Designing Transportation Human & Goods Transportation Systems	

Figure 3
Recommended Courses in Technology Education for High School

Recommended Courses

At the early middle school or junior high school level, every student should be required to take a one semester course in Introduction to Technological Systems. In this course, the four technology areas of communications, construction, manufacturing, and transportation are broadly presented.

After each middle school or junior high school student takes Introduction to Technological Systems, he or she can elect to take any or all of the four individual technology education courses that will be available. These semester courses are Communication Systems, Construction Systems, Manufacturing Systems, and Transportation Systems, and they provide the student with a more in-depth orientation to these technological areas from a systems perspective.

Figure 2 shows a chart of the recommended scope and sequence of the middle school or junior high school technology education courses.

High School Technology Education
(Grades 9–12)

Description

The senior high school technology education program is technological in nature and is designed to provide students with an in-depth foundation for career preparation at the secondary or postsecondary levels. Students will gain an adaptability leading to consumer awareness and personal enrichment as well as occupational readiness. Students pursuing engineering and scientific careers in colleges or universities will gain much from taking certain technology education courses. Also, students will develop transferable skills for life or further education. The program complements the middle or junior high school curriculum and offers sequential courses that build on previously learned content without repetition.

As a result of taking technology education students will

1. experience the practical application of basic scientific and mathematical principles.
2. make decisions regarding postsecondary technology careers, engineering programs, or service-related fields.
3. make decisions with regard to advanced vocational education programs.
4. gain an in-depth understanding and appreciation for technology in our society and culture.
5. develop basic skills in the proper use of tools, machines, materials, and processes.
6. solve problems involving the tools, machines, materials, processes, products, and services of industry and technology.

Goal: Preparation in Technology

The goal of the high school technology education program is to prepare students for collegiate and/or advanced vocational/technical programs and to be equipped

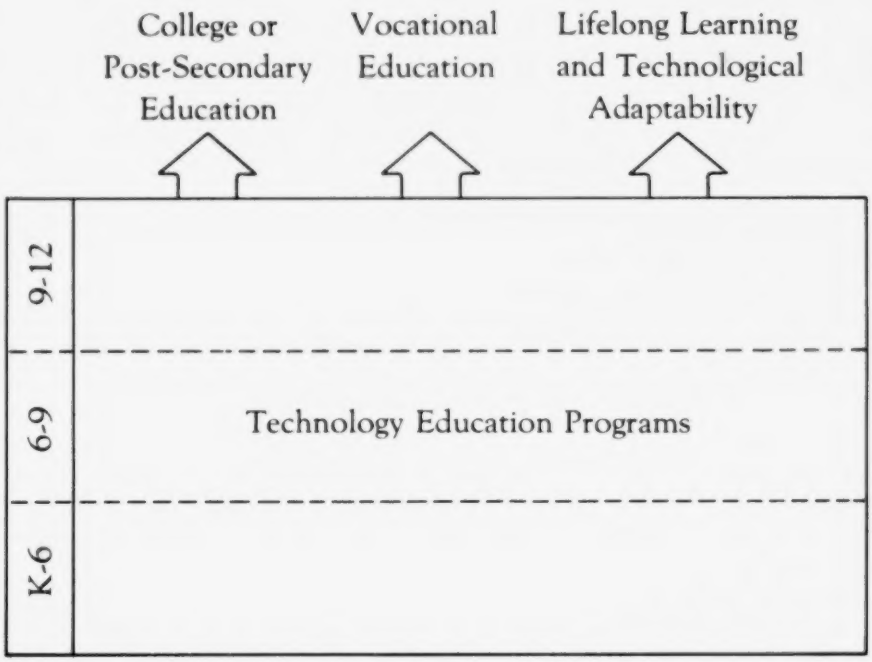


Figure 4
Career Paths for Technology Education Students

with universally transferable technological skills.

Standards for High School Technology Education Programs

It is recommended that the *Standards for Technology Education Programs* be used to establish, operate, and assess the quality of technology education programs.

Recommended Courses

There should be courses at the high school that reflect all four areas of technology education. These course offerings should be articulated and designed to complement course offerings at the middle school or junior high school level. Although each of these courses is elective in nature, each guidance coordinator should encourage all of those students who will benefit from the technological content to take these technology education courses. Figure 3 shows the technology education courses recommended for the high school.

Career Paths for Technology Education Students

As shown in Figure 1, technology education encompasses the total school program at all levels from kindergarten to grade 12. This total program must be well designed and sequential for students to gain maximum educational benefit from taking technology education.

Students who go through an articulated technology education program should be prepared for any one of three possible career goals as they graduate from high school. As a result of taking a technology education program in grades K–12, the student may wish to enter college as an engineering, scientific, architectural, or technical baccalaureate degree major. Another career path is for a technology education student to pursue a vocational career after graduating from high school. (This may also be done in high school if appropriate vocational courses are offered.) Finally, a student may take technology education for general education purposes to make him or her better prepared to live in a technological world. Hopefully, by taking a technology education program in grades K–12, students will have a quest for lifelong learning.

Summary

This section has presented the education foundation for technology education. It is based on the philosophy that technology education exists to help all students develop an understanding of every aspect of industry and technology and to aid these students in the discovery and development of their individual potential in a technological environment.

SECTION 4

Technology Education Programs in Action

The previous sections of this document have considered technology education as an issue, provided perspectives identifying suggested requirements, and described the mission and worth of technology education as an important part of the education of all people. The success of technology education becomes evident when teachers are given the support and an opportunity to place this curriculum thrust into action. Programs have been implemented at numerous locations and throughout the profession, programs in which enthusiastic teachers have pioneered innovative techniques in the implementation of their programs.

The following teachers were selected to describe and share their work with the reader. In almost every situation, these teachers are joined by colleagues in their departments who they readily recognize as important contributors to their efforts. The contributors are

Les Litherland, Everett Jr. High School, Lakewood, CO
Jerry Weddle, Hidden Valley Jr. High School, Roanoke, VA
Steven Cook, Muscatel School, Rosemead, CA
Michael Hacker, Syosset Jr. High School, Syosset, NY
Robert Daiber, Triad High School, St. Jacob, IL

Evolution of Industrial Arts Programs to Technology Education

The programs described here evolved from typical industrial arts programs that are common throughout our nation today. For example, the Syosset (NY) program was developed from a 1960s "boys-only" program that had six material-based unit shops. The Muscatel (CA) program evolved from a traditionally oriented curriculum consisting primarily of woodworking. The program progressed from one that included other subject areas (e.g., drafting, sheet metal, and plastic) to a program that studied various industries to the current studies of technology used in contemporary industry.

The overwhelming success of these programs comes from teachers who accept the challenge to improve their conceptual and professional thoughts and become better teachers and who are engaged in dialogue with colleagues involved with similar activities. The conceptual thought of these teachers transformed them from industrial arts "shop teachers" to progressive "technology teachers," with the ability and foresight to explore computers, robotics, space transportation, forms of energy, and other experiences that apply technology to solve major problems facing our society. The programs were built on the good qualities industrial arts is known for, an approach that emphasizes the importance of laboratory activities in learning about technology education.

The technology teacher must look for new ideas on leadership in our profession as a result of societal happenings.

These teachers started working with technology programs because of the advancement of our technological society. They realized that our society now dictates a new form of professional competence for our teachers. The technology teacher must look for new ideas on leadership in our profession as a result of societal happenings. These happenings require a reevaluation of the outstanding qualities of traditional programs and have created a thrust toward a new form of excellence appropriate for the years to come.

For example, Daiber of the Triad High School (IL) program noted that in a traditional general shop setting, courses that can range from introductory to capstone provide general to specific instructional content. Students begin their technology education by performing simple tasks and work toward accomplishing more complex assignments.

The courses Technology Education I, Technology Education II, Production Systems, and Technological Systems are a sequence of core courses taught in the Triad program from 9th to 12th grade. All courses focus on the central theme of providing students with an understanding of history, growth, and future development of technology. Technical and social/cultural aspects of each course help students understand the relation between technology, people, and the environment. The flexible design of courses is a key feature of the Triad Program. This aspect allows for new content to be added each year. Flexibility also helps use special classroom features that are available for a limited time. Special audiovisuals, quest speakers, new equipment demonstrations, and so on are course features that add extra value for students' technology education.

Technology courses are also composed of specific outline content that should be covered by the teacher. Some subject matter is consistent with traditional industrial arts practices. Such learning units include technical skill development to ensure that students possess the competency to use tools and equipment safely. Other lessons in technology education courses contain units in mathematics to instruct students on how to calculate cost of materials or figure the correct cutting speed of a machine. The following paragraphs further describe these selected technology programs.

Year 2050 Methodology:

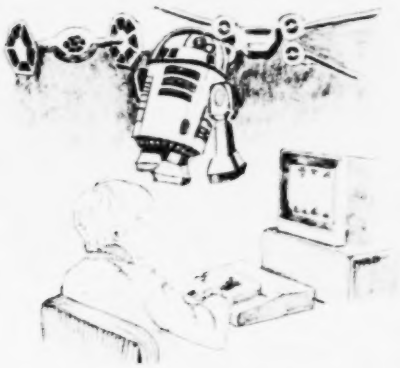
Everett Junior High School (CO)

Litherland from Everett Junior High School has taken into consideration factors pertaining to the future of his students. He is aware that the life expectancy of an adult in the year 2050 will be high in the 90s; in fact, our present age of 65 will be comparable to 85 at that time. He admits that reading statements, like those of prominent futurists, has made him shudder to think that he was to teach for the students' future.

Barring unforeseen circumstances, Litherland's students will be alive in the

year 2050. With that in mind, he teaches students to cope and exist in a world beyond imagination. One method he uses is a combination of research and development, problem solving, and decision making—an approach called "Year 2050."

In this approach, the instructor's first task is to bring all the students up-to-date on what is happening in our rapidly changing world and its relationship to technology. The following activities are designed for the students' enrichment.



- **Media Review:** Establish daily interactions (using the first 10 minutes of class) for reports on articles, pictures, or impressions from daily newspapers and weekly periodicals. The reports pertain to technologies in communication, construction, manufacturing, and transportation.
- **Library Review:** Develop a two-day visit with a media specialist in the media center. Students are given methods and directions that enable them to use the center's resources. The emphasis is on the "happenings" of current technologies that affect our lives socially and as consumers.
- **Visual Blasts:** Use every available space in the lab to display the students' pictures and articles. These visuals are changed every week. Therefore, the students must maintain a flow of information for the displays. By having the "blasts" around them as they work on their assignments, the students are almost forced to absorb literacy of the technological advancements.

These information-collection methods enable students to become familiar with a technologically based world while they are learning the basics of drafting. These drafting rudiments are necessary to take the students through their first task of the year 2050: creating a set of scale drawings or a plan of a concept. These reviews and "blasts" are continued throughout the processes and procedures segment.

To release the students' minds from their "locked" positions of living in the present, Litherland approaches them with present and possible future situations and compares them with situations in the past. He uses a show-and-tell approach by showing what people were predicting 50 years ago with the book, *Wasn't The Future Wonderful?* Comparisons are made of technology during his life span as compared with the present technologies, like propeller airplanes to the SSTs. As in George Orwell's book *1984*, many of the predictions were inaccurate, but it shows students that developing a concept of the future is not risky or embarrassing, for many have predicted before them. The students then use present technologies to formulate ideas of what could be, such as photovoltaic cells, lasers, robotics, optic fibers, or any other of the hundreds of advancements.

Next, students are made to use the basic skills of drafting and media reviews to design/develop what they believe could be used in the year 2050. Litherland has used all four clusters (manufacturing, communications, construction, transportation) with this assignment but has had the greatest success when the assignment was narrowed to the area of transportation. The students realize that they will be constructing a scale model of their concept, so many of the fine details are purposely overlooked. The concept is, however, carried out in more detail in students' research and reports.

While the students are developing their choices within the transportation cluster using drafting techniques, they are also researching the media to support their varied choices of mass transit, hovercrafts, planes, and so on. During this phase, the *safe* procedures and processes of the lab are presented. The basic offerings of the physical plant involve "wood" and "plastics." One teacher goal is that as students build their scale models, they are able to use every operation available with the *existing* machines and materials. Students make all decisions on how and what is employed to build their models, with guidance from Litherland.

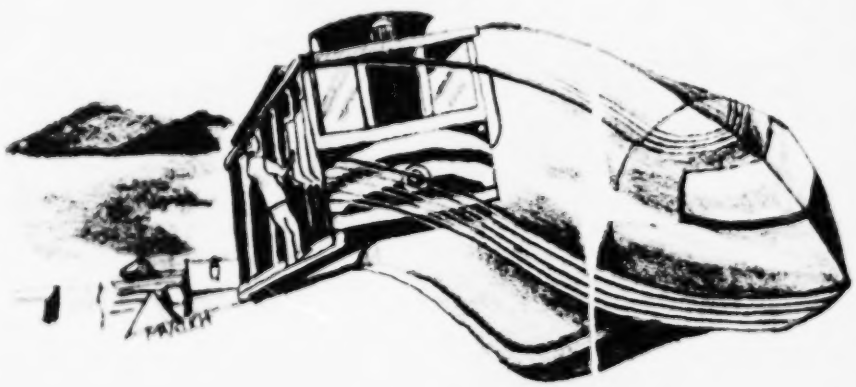
By demonstrating and presenting during the drafting/planning phase, the students are able to move into the construction segment as they finish their scale plans. This provides for individual differences and permits students to move directly into each task as the situation demands.

The next task of bringing the chosen concept into a better visual image is for students to construct a scale model of their design. They have the opportunity to choose the scale, processes, procedures, and materials to build the model to suit their tastes. This will promote the decision-making process. It is this problem solving with "hands-on" experiences for which technology educators should be known. It is this feature of technology education that will enable our students to live better in the future, in the year 2050.

While the construction of the models is proceeding, reinforcement of other technologies can be presented, such as finishing, in-depth research, preparations for presentations, and spin-offs of initial thrusts.

After the model is completed, each student is assigned to use the drawings, research, and model to present their concept to the class. Not only do the students learn from one another, they are also able to share the experience of a final seminar. This interaction is actually the apex of the course, for the seminars provide organizational and communication building blocks for the foundation of the students' future.

Finally, all classes have a combined "show" of the models. Invitations are mailed to parents, administrators, fellow



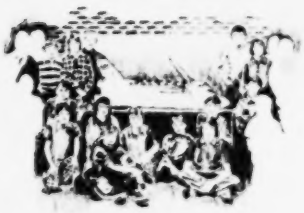
students, and the various media. This display enables the students to explain concepts to others once more, thereby reinforcing their beliefs of our world flourishing in the year 2050.

Space/Transportation Technology:

Hidden Valley Junior High School (VA)

Many of the procedures/methodologies used by Litherland are practiced by Weddle, who has been building his school's program since 1972. Weddle uses the machines, tools, and materials that were once an end in themselves in industrial arts to teach about technology. Students still learn about the machines, tools, and materials; but rather than building spice racks, bookshelves, or ceramic mugs, they learn about our technology, which changes daily.

Much of Weddle's innovation grew from his work at NASA's Langley Research Center. As a result of the NASA experience, the students completed a group space technology project by selecting topics relating the space technology. The topics range from the space shuttle to Skylab to the crawler transporter (a massive machine that moves the space vehicles from the assembly building to the launch pad). Using NASA's personnel system provided by Langley, the students organize themselves as a company and select a company name. The school's photo lab is used to make identification badges for all students, who are required to wear the badges when working in the lab.



The project director and his or her assistant, both students, are elected by the class. The remaining students fill out resumes and interview for the positions needed to complete that particular project. Some of the job titles are design director, research director, fabrication director, and public relations director. Each student has a job title, job description, and task to carry out.

A class period is spent learning how to write business letters, and each student is required to write one letter requesting information on the topic the class is studying. The information received is used to write research papers and provide specifications for design and construction of a detailed scale model. As information arrives, it is sorted and categorized by topic and filed by the research director. The information received provides other subcontractors' addresses, and more letters are written. The space shuttle, for example, has literally hundreds of subcontractors. The school now has an exhaustive library of space technology brochures, maps, photographs, specifications, technical manuals, blueprints, historical documents, and so forth.

The constructed models are made from a variety of materials. Innovative design and accurate construction must be coordinated by the students so that all parts and sections fit properly during assembly. For example, wheels for a lunar rover were made from two metal jar lids soldered back to back with plastic vacuum cleaner hose wrapped around them. Space shuttle engines were made from round, tapered sheet metal ducting adapters. The models are now displayed on the walls of the school, with many of the projects displayed in such places as Langley Research Center and educational conferences. They provide a great boost for the profession and the school's program.

Langley Research Center's Public Affairs Office has provided two mobile display/lecture units for Weddle's school. One mobile unit display was set up for a week. The school lab was converted into a NASA "museum," which students and the general public visited daily.

Weddle's school has had other types of technology-oriented group projects through work with his colleague Bob Warren. Two were completed in separate 18-week transportation classes. A wind tunnel was constructed as part of a rocketry unit in which the stability of rockets was checked and studied. Students are now able to design a rocket and test its stability before an actual firing.

The most recent venture is a computerized flight simulator. Students can climb into their 8-ft long, carpeted airplane cockpit and "fly" the plane while learning the

principles of flight. The computer program, one of many available, provides experience flying in sunny weather, foggy weather, and with or without instruments. Distance-measuring equipment tells how far the plane is from the end of the runway, and the rate of descent is displayed. In case of a crash, a telegram is sent to the next of kin telling them of the crash and why it occurred. The simulator has been one of the most motivating projects and has attracted much community attention.

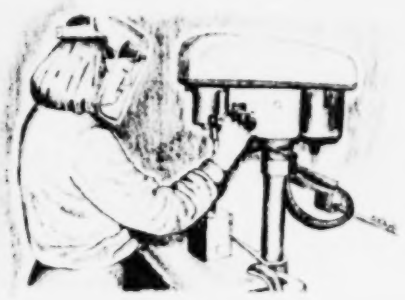
Weddle and Warren are now experimenting with systems that are being integrated into all areas, including construction, manufacturing, communications, and transportation. Work is also being completed to use computer instruction to teach how computers control robots, to develop drawings, and to teach the principles of flight.

Manufacturing Technology:

Muscatel School (CA)

Cook at the Muscatel School emphasizes manufacturing technology in his programs. Technology is used as a discipline base for the study of five commonly accepted areas of study: (a) research and development, (b) production planning, (c)

line production, (d) materials and processes, and (e) company organization required to make technology work. The laboratory experience supports the cognitive and affective learning taking place in the classroom. Students are also encouraged to use their other classes as information resources. This supportive relationship of the hands-on learning experience makes this kind of program successful.



The *research and development function* is conveyed to the students by having them brainstorm ideas, develop sketches, build models, complete working drawings, and construct a prototype. The students then complete the steps necessary to set up and run a production line. This experience demonstrates how technology can be used to set up an efficient production line, better known as *production planning*. The prototype is analyzed, a flowchart is created, an operation sheet is developed, plant layout considerations are made, tooling is completed, jobs are assigned, and personnel (students in the class) are trained.

The actual *line production experience* is stimulating for both the students and the teacher. At this point, much of the learning has already taken place. Students see, through practical experience, why industry functions the way it does. Cook motivates students at this point with contests between classes to see which class can produce the largest quantity and best quality of product. The students establish the criteria for evaluating the contest entries. The school principal, board members, other faculty members, and people from industry are invited to see the "factory" in operation.

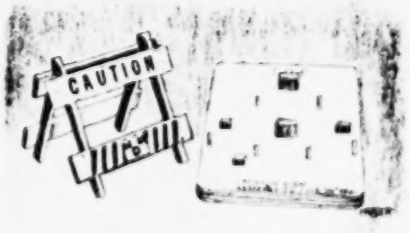
Materials and processes are explored through categorization techniques that allow students to create charts and compile examples of the various products in which procedures have been used to change raw materials into a finished product. Contemporary procedures, such as robotics and the "lightless factory," are a part of this exercise.

Cook's methodologies create a setting in which a *company organization* is developed. His students are involved in setting up the company and the day-to-day operations of their own enterprise. They elect company officers, conduct employment interviews, select a company name and trademark, and hold union elections. They also use a time clock to punch in and out each day, fill out an employment application, and receive a weekly paycheck.

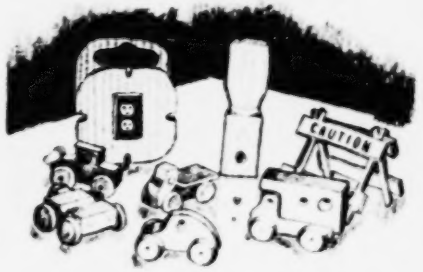
Technology Education:

Syosset Junior High School (NY)

Manufacturing technology can be taught using numerous methodologies. As a contrast to Cook's Muscatel School program, the manufacturing program at Syosset is a 10-week course for eighth-grade students. Films, lectures, and hands-on activity are used to contrast primitive methods of production with contemporary methods. Both programs use actual experiences in mass producing products using hand tools, machines, and materials. The Syosset program attempts to teach how manufacturing influences the cultural context; how to use materials, tools, and machines safely; and how to explore career opportunities.



Teachers structure a mass production line that students run as their initial experience during the first several days of class. From this experiential base, students analyze production methods. Related information is taught through a materials-testing program, in which students make decisions about appropriate materials for future products on the basis of their test results. Student activity is guided by a flow chart of procedures, which includes evaluative check points, related assignments, and instructions.



The students work with four different materials to produce a product using hand tools and machines. They test the physical properties of materials using materials-testing apparatuses. This activity is done within small groups, with each group doing different tests. The groups communicate the results of all tests in a formal presentation to the entire class. The intent is to stimulate the development of communications skills, as well as to provide technical information. Assembly-line techniques are used that require multiple operations and a variety of clever jigs and fixtures. The students mass produce enough products for their entire class in a 40-minute period.

Syosset has a second required course in communications technology. This 10-week course for seventh-grade students involves

contact with a variety of communications media. Students circulate through 6 activity stations in small groups. Stations include amateur radio, offset lithography, videotape/television, technical drawing, computer communications, and photography.

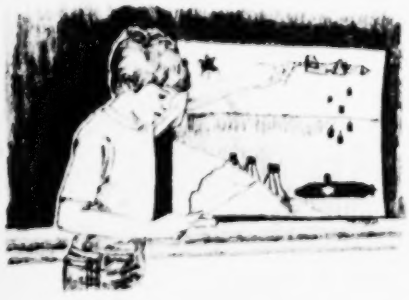
Every attempt is made to create an understanding of the pervasive role communications technology plays in advanced societies and to provide students with an ability to communicate ideas, process information through the use of technical means, and explore communications-related career opportunities. After a series of preliminary lessons, students receive instruction from self-teaching devices using filmstrips and tapes developed by the department. This course provides an exceptional opportunity for interdisciplinary experiences.

Other activities of the communications class include an oral history project with the English classes. Interviews are conducted with senior citizens in the community. The tape-recorded interview is transcribed and keyed into a word processor. Photographs of the senior citizens, along with their stories and recollections, are printed on placemats, which are then distributed to local restaurants so visitors can learn about the community.

Students practice foreign language and social studies skills by talking to students in other countries using an amateur radio. They write scripts for videotape production and generate a completed tape of a product or service advertisement, newscast, or how-to sequence.

Another activity is the printing of humorous posters advertising technology education. A computer terminal and modem are used by which students communicate with other users over telephone lines through a commercial data base.

Syosset also offers a ninth-grade electronics elective that meets daily for one year and is geared to students of above average ability in mathematics and science. The course treats concepts of direct and alternating current, Ohm's law, Kirchhoff's laws, generation, inductance, capacitance, reactance, and impedance. A major portion of this program involves the study of high-technology industries from the viewpoint of their electronic underpinnings.



The students are introduced to the basic principles of electronics as a means of stimulating interest in engineering and other technologically related careers. They gain insight into the electronic technology that pervades virtually all of the new and emerging high technologies. Students use electronic components and test equipment to construct experimental circuits and build working prototypes.

The unique aspects of the program evolve when the students are requested to pick an area of high technology from a list they generate and then present an oral and written research report to the class about the technology. They are asked to determine who the key players are in the industry, interview technical personnel by telephone or personal visit, and solicit information about

1. the nature of the technology involved.
2. the present state of development of the technology.
3. who the major competitors are.
4. the future of the technology, circa 1990.
5. the impact the technology has had on society.
6. job titles and salary ranges.
7. educational requirements for professional and technical personnel.
8. the role of electronics in the particular technology.

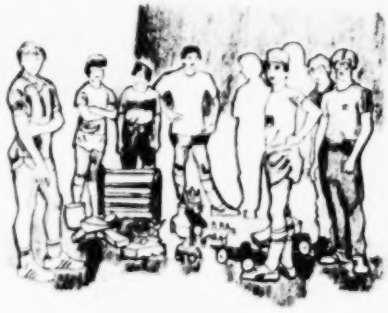
Sample activities that are completed include using a given set of components and instructions to follow procedures in workbooks. The students construct experimental circuits and use test equipment to verify theoretical principles. They are given a kit of electronic components and a schematic diagram to construct a printed circuit board and wire an electronic device.

Approximately once every two weeks, a student presents an oral and written research report about an area of high technology. The list of topics that was generated this past year included cable television, satellite communications, lasers, robotics, electronic warfare, computer technology, biomedical engineering, microelectronics, printed circuit fabrication, fiber optics, ultrasonics, and electronic prospecting (for gas and oil). Students are encouraged to arrange field trips to local high-technology industries as a follow-up activity to their reports.

This school program also has a ninth-grade elective stressing problem solving, decision making, and creative thinking. Students use tools and machines to produce a product of their own choice. Students are encouraged to seek creative solutions to technical problems while using and improving their technical skills. The class meets every day for one semester.

Skills are developed in technical problem solving, and innovation is encouraged through unconventional solutions. The students are equipped with a base of skills in the safe use of tools, machines, and materials sufficient to provide a small amount of competence.

After building a product of their own choosing, students are challenged to solve a technical problem. In small groups, they develop prototypical solutions, assess results, and modify the design until it meets the criteria. Their designs are entered in a contest for viewing by schoolmates and the general public.



Other products produced by students have included a hanging cradle, an inlaid backgammon board, band saw boxes, and loudspeaker baffles. The students have solved such problems as designing a device, using between 1 and 4 soda cans as integral design elements, transporting a raw egg down an 8-ft ramp inclined at a 15° angle, breaking a 6-in. diameter balloon (taped to the floor, 5 ft past the end of the ramp) with a lead pencil, and traveling a

total horizontal distance of 25 ft at a speed greater than that of any other competing groups' entry.

Triad High School Technology Education:

St. Jacob (IL)

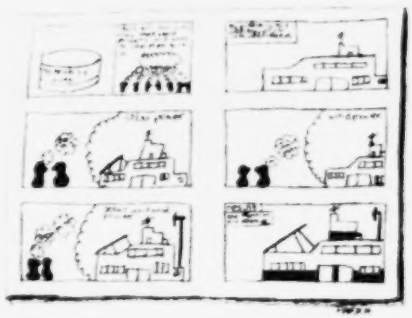
Beyond the philosophical perspective of technology education, the classroom experience depicts the true rationale for this area of study in today's schools. The number of meaningful learning units that can be developed to enhance the student's cognitive, psychomotor, and affective development is endless. The new subject matter continually promotes student interest and involvement in coursework. Students exhibit enthusiasm and high motivation in the laboratory area that may be the setting for a wind tunnel experiment, solar panel test, or trial operation of a newly designed production robot. Individuals who have not yet encountered technology education firsthand in the classroom face an exciting instructional situation.

During a five-year technology education curriculum project at Triad High School, the faculty members have learned much about courses, content, and activities. These factors are of equal importance and are significant to implementers of technology-based programs. The common questions asked by classroom teachers are,

1. What are course titles for technology education classes?
2. What sources of information are used to provide content?
3. What types of activities are conducted in technology education programs?
4. How do students react to technology education classes?

A logical way to answer such broad questions is to examine a technology program in action through a brief description of the course offerings. These courses include two courses in technology education: production systems and technological systems.

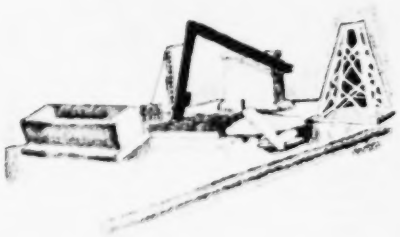
The courses, content, and activities that make up the technology programs at Triad High School exemplify a practical approach to teach technology-based subject matter.



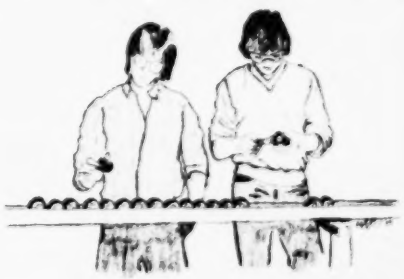
Technology Education I is the introductory course to the entire program. The one-year class is divided into four conceptual areas: communication, energy use, production, and transportation. Each section provides students with a general understanding of the area of study. Students acquire basic technical skills and learn about social/cultural, economic, and ecological aspects of these major conceptual areas. The students learn to use a new piece of equipment (e.g., computer) in the production lab to solve technical-related problems, such as board feet problems and cutting speed requirements. Cartoon posters are sometimes designed as a student activity in a unit, such as with energy use. The posters illustrate how people can apply new technology to solve current problems. Both activities represent examples of basic learning units for an introductory technology course.

Technology Education II is a competency-based class that strongly focuses on further developing students' technical understanding of tools, materials, and processes. The course is divided into two semester sections (one semester of metallics and one semester of polymers). In addition to learning advanced tool and machine operations, students investigate the technical procedures by which new technology is developed. Each student is required to complete a technical project in each section, as well as a working technology model. Students may randomly select a project idea. Models of lasers, wind generators, robots, solar planes, and self-propelled systems are a few of many models that class members have built. To accompany the engineering of the model, each student develops a formal paper that explains (a) the social need of this technology, (b) the operating features of the model, and (c) ways the model could be further developed. Upon completing Technology Education II, students are competent to enroll in the courses Production Systems or Technological Systems.

Production Systems is a final course that highlights students' technology education. This course provides students with an understanding of how production is done. Students organize a corporation to produce a selected product. The class is centered around the hands-on experience of processing materials to produce goods, so the instructors attempt to interrelate many aspects of new technology in manufacturing products. Many approaches may be used to help students comprehend a worker's role in contemporary manufacturing. Students may work on many activities, such as making minor adjustments to a pick-and-place robot that places plastic sheets in an oven and then removes the sheets and places each one in a forming mold. This production project involves hot materials and illustrates how robots can be applied in production for safety.



Other related aspects of manufacturing, such as quality control, are also stressed. Another major portion of this course is designed to increase students' technical know-how of equipment and manufacturing systems. For example, students may gain a first-hand experience in servicing a conveyor. Providing students with prob-



lem-solving and decision-making challenges is a major educational objective of this course.

Technological Systems is an advanced two-year course that involves research-based activities concerning communication, energy use, production, and transportation. Examples of student research projects include robotics and the conveyor. Both projects were research assignments that students built in one quarter of the class. To construct such large, accurate technology projects, students need sound technical skills. The first year of the Technological Systems class devotes a percentage of class time to developing technical skills further.

Technological Systems is also a class that analyzes the social, environmental, and economic aspects of technology. Students read, write, and develop charts that explain their research. At the end of the course, students should have significantly increased their technological literacy level.

In a technology education program such as the one at Triad, instructors can support technology content through outside class activities. Each quarter, an attempt is made to provide a special unit that is an attention getter for the department. These activities are usually a demonstration or display. For example, a bridge construction activity that called students' attention to the national problem of bridge and road deterioration was conducted. The activity was initiated by faculty members building two bridges. After the bridges were displayed, students were given tickets on which to write the approximate weight they thought each bridge would hold. Students gathered every morning before classes to observe weight added to each bridge. A final prize was awarded to the person that provided the best weight approximation.

Such activities make teaching students about technology exciting, for both the teacher and the student. These activities also promote good student and teacher relations in a technology education department. The experience of working with young people, listening to their perspective of new technology, and enhancing their educational growth is professionally rewarding for the teachers.

Summary

The teachers who have provided descriptions of their programs in this publication do not know all of the challenges that lie ahead for them or their students. Yet, they *do* know that they can expand their scope to explore the many exciting avenues of technology education. They have experienced failures and successes in both the classroom and laboratory. They continue, however, to explore new areas of research and developed materials to become outstanding educators in tune with the leadership of the profession.

There are many other teachers who are experiencing the same type of excitement in their technology programs. They are not necessarily all in the United States, for the entire world is involved in a similar educational movement.

The mission of professionals in technology education must be to increase understanding of technology among all people. This curriculum thrust works toward that mission by presenting the insight, providing the drive and communication, and questioning the efficiency of methods and approaches while delivering materials of significance to people who will be experiencing sophisticated technology for the rest of their lives.

Additional copies of this publication and membership information are available from the International Technology Education Association, 1914 Association Drive, Reston, VA 22091, 703/860-2100.